SOCIO-ECONOMIC FACTORS INFLUENCING THE ADOPTION OF IMPROVED RICE PROCESSING TECHNOLOGIES BY WOMEN IN JIGAWA STATE, NIGERIA

BY

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A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTER OF SCIENCE DEGREE IN AGRICULTURAL EXTENSION AND RURAL SOCIOLOGY.

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DECLARATION

I hereby declare that this thesis titled "**Socio-economic Factors Influencing the Adoption of Improved Rice Processing Technologies by Women in Jigawa 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 **"Socio-economic Factors Influencing the Adoption of Improved Rice Processing Technologies by Women in Jigawa State, Nigeria"** carried out by Ado NASIRU meets the regulations governing the award of the degree of Master of Science in Agricultural Extension and Rural Sociology of the Ahmadu Bello University, and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

I dedicate this work to my entire family for their patience and support during the course of the programme.

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My greatest gratitude goes to Allah (SWT) who gave me the wisdom to undertake the programme. I give my profound thank to the Chairman of my supervisory committee, Prof. D.F. Omokore and the member of my supervisory committee, Prof. T. K. Atala for the help, support and high level of encouragement during the course of this work.

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ABBREVIATIONS

ACCOMEX	Agricultural Commodity Exchange Market
ADP	Agricultural Development Project
CAADP	Comprehensive Africa Agriculture Development Programme
CARD	Coalition of Africa Rice Development
DAPRS	Developing Agricultural Policy and Regulatory System
ECOWAS	Economic Countries of West African States
FMA&WR	Federal Ministry of Agriculture and Water Resources
GDP	Gross Domestic Products
IRRI	International Rice Research Institute
JARDA	Jigawa State Agricultural and Rural Development Authority
LGA	Local Government Area
MARKETS	Maximizing Agricultural Revenue in Key Enterprises
MDG	Millenium Development Goal
NCRI	National Cereal Research Institute
NEEDS	National Economic Empowerment and Development Strategy
NFSP	National Food Security Programme
NGO	Non-Governmental Organization
NPC	National Population Commission
NRI	Natural Resources Institute
UNDP	United Nations Development Programme
WARDA	West African Rice Development Association

ABSTRACT

The study examined broadly the socio-economic factors influencing the adoption of improved rice processing technologies by women in Jigawa State, Nigeria. The specific objectives were: (i) describe the socio-economic characteristics of the women rice processors in the study areas (ii) investigate the level of awareness of improved rice processing technologies by women rice processors in the study areas who were not trained (iii) determine the level of adoption of the technologies by both trained and untrained women rice processors in the study areas (iv) determine the socio-economic factors that influenced the adoption of the improved rice processing technologies by the trained and untrained groups (v) determine the constraints to the adoption of rice processing technologies faced by women in the study areas. Questionnaires were administered to 240 respondents; (120 trained and assisted with improved rice processing technologies by the Jigawa State Government and another 120 who were neither trained nor assisted with the improved rice processing technologies). Data collected were analysed by the use of descriptive frequencies and percentages, and inferential multiple regression analysis statistics. The study found that, the mean age of the respondents is 34 and the average household size was 6. Similarly, 70% of the respondents do not have formal education and 70.8% and 100% of the trained and untrained respondents respectively do not have contact with extension agent. The study further revealed that 45.8% and 54.2% of the trained and untrained respondents respectively has been in the processing business between 11-20 years which shows they are quiet experienced. The study revealed that 41.6% of the untrained groups were aware of all the technologies. The adoption rate of the technologies was generally low with the exception of rice mill which was adopted by 100% of the respondents. The regression analysis revealed that age (-0.102), processing experience (0.069), membership of association (0.248) and access to credit (0.094) significantly influenced the adoption of the improve rice processing technologies by the respondents. The major constraints to adoption of the improved rice processing technologies by the respondents among others include inadequate extension visits, inadequate credit facilities, inadequate availability of the equipment and No attractive price differences between the improved processed and locally processed milled rice. Based on the findings of the study, it is recommended that extension visits should be intensified so that processors can have more contact with extension agents. The level of awareness was low, more awareness creation should be done through step down training by the trained group. The level of adoption was low even though people patronize the product due to quality, processors should organize themselves into groups so that they can have good bargaining power against the middlemen. Women processors should be organized into groups, trained and linked up with financial institutions to enable them obtain credit to buy improved rice processing equipment to boost their processing business. Similarly, women processors should be enlightened to join adult literacy classes so that, at least they can comprehend instructions related to improved technologies in order to fast act adoption process.

CHAPTER ONE

INTRODUCTION

Agriculture remains a key component of the Nigerian economy; currently, contributing about 25% of the Nigerian GDP, employing about two-third of the work force and accounting for about 5% of total exports. Similarly, Agriculture constitutes the single largest contributor to the well being of the rural poor, sustaining 90% of the rural labor force (CARD, 2010). Nigeria with a population of over 140 million people and a land area of 923,768 square kilometers has a total of over 79 million hectares of cultivable land. Out of this, 4.6 million hectares are suitable for rice production. Meanwhile, only about 1.8 million hectares or 39% is currently utilized for rice cultivation (CARD, 2009).

Rice serves as a food security commodity in Nigeria as well as being the fourth major cereal crop after sorghum, millet and maize both in terms of output and cultivated land areas. The estimated annual rice demand in the country is put at 5.0 million metric tonnes while it produces on the average about 3.0 million metric tonnes milled product leaving a deficit of 2.0 million metric tonnes which is bridged by importation (NCRI, 2009). Although, there was an increase in rice production between 1981 to 1990, average consumption was 15.8 kg//head/year in 1981 – 1990, and by 2007 it was 27kg/head/year. In 2006 self-reliance has decreased from 87.4% to 71% (National Bureau of Statistics Report, 2007). Total paddy requirement to meet National per capita consumption of 30kg/head/year is 6.5 million tonnes (4.2 million tonnes of milled rice). This will provide an aggregate processing gap of 3.7 million tonnes of paddy (NCRI, 2009).

The Nigerian government has made concerted efforts to encourage rice production and processing through its rice Transformation Action Plan under the Agricultural Transformation Agenda. According to Adesina (2013), the rice transformation action plan has a target to make Nigeria self-sufficient in rice production by the year 2015. Government plans to ban rice imports as from 2015, so as to put an end to the ₦356 billion yearly import bill on the commodity. According to Adesina (2013), in 2012, the local rice programme introduced by the government led to the production of about 690,000 metric tonnes of the staple, which was said to be 140 per cent higher than the target set for the year. This results in the emergence of new rice processing industries, in some states such as Ebonyi, Kano and Jigawa and sufficient raw materials to the existing ones. Similarly, it leads to the stabilization of the price of the imported rice which increases in price every year.

Through the rice programme, a United State Investment Company Dominion Farm has commenced $40 billion investment in 30,000 ha of land in Taraba State to reduce the country's import bill by over ₦50 billion. To further encourage rice production, new fiscal measures were introduced by the government, like increase in Tariff on brown rice and levy on imported finished rice to encourage local production. As a result, 13 new private sector mills with an estimated total capacity of 240,000 metric tonnes have sprung up between 2012 and 2013, buying and processing local paddy.

To ensure that Nigeria has in place industrial capacity for international quality grade milled rice that can compete with imports, the Federal Ministries of Agriculture and

Finance recently concluded arrangement to facilitate the establishment of 100 large scale integrated rice mills with total capacity of 2.1 million metric tonnes nationwide. The mills, which will be owned and operated by the private sector, are to be financed by China EXIM Bank through a low interest rate facility of $1 billion, thereby making Nigeria to have full industrial capacity to mill and replace all the rice it currently imports and became an exporter of finished rice to other African Countries. Current government incentives to support investors in Agriculture includes: New fiscal incentives to encourage domestic imports substitution, removal of restrictions on areas of investment and maximum equity ownership in investment by foreign investors, no currency exchange controls – free transfer of capital, profits and dividends, Constitutional guarantees against nationalization/expropriation of investments, zero per cent duty on agricultural machineries and equipment imports, pioneer tax holiday for agricultural investments, duty waivers and other industry related incentives e.g. based on use of local raw materials, export orientation etc.

New policies, institutions and financing structures to drive the sector growth also includes; deregulation of seed and fertilizer sectors, marketing reforms to structure markets, innovative financing for agriculture and new Agricultural investment frame work. Government has fully deregulated the fertilizer and seed sector and sanitized the fertilizer subsidy programme. Private sector sells fertilizer to farmers at market price "minus" the fertilizer voucher discount provided by the government. According to Adesina (2012), 94% of actual farmers receive the subsidized fertilizer and seeds under the voucher programme and the states and federal government coordinate to distribute fertilizer vouchers to targeted farmers and currently 97% of

states/LGs implemented the growth enhancement support for the fertilizer and seed subsidy.

14 sites were selected across Nigeria for the first set of staples crop processing zones under the agricultural transformation agenda. Some of the crops include rice; Kadawa valley in Kano State with core investor being Dangote, Ikwo in Ebonyi State with core investors Ebonyi rice, UNDP, Ebonyi Government, Gassol in Taraba State with core investor Dominion Farms. Tomato, Kadawa Valley with Dangote as core investor. Similarly, Wannune in Benue State with Delmonte Foods as potential investor. Therefore, with the current programmes going on, it is clear that rice processing technology is an important business in the country and to understand the concept very well the key words are defined.

American Heritage Science Dictionary (2002), defined technology as the scientific knowledge to solve practical problems, especially in industry and commerce. It may also mean the specific methods, materials and devices used to solve practical problems. According to Wikipedia, Technology (from Greek, techne, "art, skill, cunning of hand") is the making, modification, usage and knowledge of tools, machines, techniques, crafts, systems and methods of organization, in order to solve a problem, improve a pre-existing solutions to a problem, achieve a goal, handle an applied input/output relation or perform a specific function.

The Merrian-Webster Dictionary offers a definition of the term technology as "the practical application of knowledge especially in a particular area" and " a capability given by the practical application of knowledge". Similarly, oxford dictionary

defined technology as the application of scientific knowledge for practical purposes, especially in industry. On the other hand, Rice processing entails methods or treatment used to prepare rice for use or preservation. It includes the operation that maintains or improves the quality of rice or changes its form (NCRI, 2009).The purpose of rice processing is mainly to reduce food losses, enhance food security, promote economic growth, generate income especially for households, stimulate local production, encourage and stimulate the industrial sector and facilitate participation in international trade(NCRI, 2009).

In line with the Federal Government effort to achieve self-sufficiency in rice production and complete substitution of imported rice by 2015, the Jigawa State Government through the Jigawa State Agricultural and Rural Development Authority (JARDA), trained selected women groups whose major occupations were rice processing and introduced to them improved rice processing equipment in 2005. These equipment feature simple design and the technology in them can be applied in the traditional equipment to make them process quality products. For example, the local pot can be modified to substitute the improved rice parboiler by providing a false bottom and outlet. Similarly, local destoning sieves can be made using local available materials at home using 2"x2" wood and a wire mesh of 1mm opening. Concrete drying slabs can be substituted with locally available tarpaulin for drying. The women were also trained on enterprise development to help them improve their business. The whole programme is aimed at encouraging local rice production and processing to achieve self-sufficiency and food security in the country.

1.1 Problem Statement

> Women play indispensable role in agriculture and in improving the quality of life in rural areas. However, their contribution often remains concealed due to some social barriers and gender bias despite their major responsibility in household, health and nutrition, their role in agriculture covers all facets of agro-business, including food production, livestock production, fishing as well as farm management. Encouraging small scale women rice processors to adopt the use of improved equipment to process quality milled rice that would compete with imported milled rice would encourage local production of the commodity, because, using the equipment would make them to produce more products and require more paddy for processing. Therefore, the demand for paddy would be more and farmers would be encourage to expand production.

Consequently, the government of Nigeria has actively intervened in the Nigeria's rice economy over the last few years using measures including import tariffs and import restrictions as well as setting up special presidential committees on the product. These policy measures notwithstanding, domestic rice production has not increased sufficiently to meet the increased demand despite the great potentials abound for Nigeria to achieve large-scale production of paddy, even though this has to be complemented with capacity for high quality post-harvest technologies for processing, storage and marketing to serve both domestic and foreign markets. Focusing on this strategy, the Jigawa State Government therefore selected four women groups whose major occupations were rice processing and trained them on improved rice processing technologies using Improved rice processing equipment (improved rice parboiler, local destoning sieves, stitching machine, weighing scale, concrete drying slab, rice mill and packaging materials) to help them to provide consumer with high quality stone-free rice . At the end of the trainings, each group was assisted with a complete set of the improved processing equipment and it was expected that each group would use the equipment and continue to apply the technology learned during the training to produce better quality products.

Since the equipment were given to the women groups, there was no report of whether they have been using the equipment and adopted the technologies in them or not. Therefore, this research is to find out whether these women in the various groups have adopted these technologies or not. If they have adopted, what are the socio-economic factors that influenced the adoption of those technologies? For this reason, the following research questions were established.

i. What are the socio-economic characteristics of women rice processors both trained and untrained in the study area ?

ii. What is the level of awareness of the improved technologies by the untrained women rice processors?

iii. What is the level of adoption of these improved technologies among the trained and untrained women rice processors ?

iv. What are the socio-economic factors that influenced the adoption of the improved rice processing technologies by both the trained and untrained women rice processor in the study areas?

v. What are the constraints to the adoption of improved rice processing technology faced by women in the study area?

1.2 Objectives of the Study

The broad objective of this study is to assess the socio-economic factors influencing the adoption of improved rice processing technologies by women rice processors in jigawa state, Nigeria.

The specific objectives are to:

(i) describe the socio-economic characteristics of the women rice processors in the Study areas.

(ii) investigate the level of awareness of improved rice processing technologies by women rice processors in the study areas who were not trained.

(iii) determine the level of adoption of the technologies by both trained and untrained women rice processors in the study areas

(iv) determine the socio-economic factors that influenced the adoption of the improved rice processing technologies by the trained and untrained groups.

(v). determine the constraints to the adoption of rice processing technologies faced by women in the study areas.

1.3 Justification

The traditional rice processing method which includes soaking of the rice overnight and steaming or boiling without cleaning of the paddy is labour intensive, although the method offers some social and economic benefits to the generality of the community, it is most of the time unprofitable to the processors (JARDA, 2006). This made the State government to train some women in order to improve their skills and introduce improved equipment that could be adapted by the women to modify their local equipment in order to produce good quality milled rice.

Despite the contribution of the rice processing industry to food security in jigawa state, critical empirical studies have not been conducted to examine the factors influencing the adoption of the improved rice processing technologies by women processors in the study area. Therefore, the findings of the study would be useful to the manufacturers of the improved rice processing equipment by identifying which equipment the women processors require and which ones need modifications. Government would find appropriate equipment that should be promoted for adoption and which area requires training to be given to the processors to improve their skills. The study would also contribute to the information that could guide future researchers who might be interested in carrying out further works on rice processing.

1.4 Hypothesis of the Study

There is no significant relationship between the socio-economic characteristics of women rice processors and adoption of improved rice processing technologies.

CHAPTER TWO
LITERATURE REVIEW

2.1 Agricultural Development in Nigeria

Agriculture has been identified as a major driver of growth in the Nigerian economy. The current agricultural and rural development policies and strategies are being pursued within the framework of the 7-Point Agenda and the successes and lessons of the National Economic Empowerment and Development Strategy (NEEDS), which was Nigeria's Poverty Reduction Strategy Paper (PRSP) launched in June 2004. In March 2007, a second phase of NEEDS, NEEDS II, was launched. The agenda, which was adopted by government in May 2007, states the broad policy priorities for implementing economic reforms and development programmes in Nigeria. It describes the key policy imperatives, directive principles and instruments in promoting sustainable economic growth for the achievement of the MDGs by 2015 and vision 2020. The main agricultural goals enunciated under the agenda are diversified economy, food security, employment generation, economic linkages, exports and poverty reduction. It acknowledges that low productivity, low quality of private sector investment, lack of domestic and international competitiveness, weak domestic policies and institutions, inadequate funding and lack of organized land titling and tenure are the main challenges of agricultural development in Nigeria (FMA&WR, 2012). The key agricultural elements of the agenda are land reform, commercial agriculture, irrigation development, institutional support and market stabilization. The major policy offshoots of the 7-point-agenda are the National food security programme and the five point agenda.

2.1.1 National Food Security Programme (NFSP)

Within the framework of the 7-point agenda, the National Food Security Programme document was published in August 2008. According to the Federal Ministry of Agriculture and Water Resources, its objective is to "ensure sustainable access, availability and affordability of quality food to all Nigerians and for Nigeria to become a significant net provider of food to the global community."The key features of the programme include:

(i) Providing a conducive environment for private sector involvement.

(ii) Encouraging large scale commercial farming with strategic linkages to small holder farmers.

(iii) Significantly reducing post-harvest losses through adequate storage, processing and appropriate market outlets.

The policy thrusts of NFSP are import substitution, substantial food security, promotion of modern agricultural practices, natural resource conservation and commodity focus.

2.1.2 Investment programmes under the NFSP/7-point agenda

The drive to achieve the food security and national development objectives as exposed in the 7-point agenda makes the strengthening of agricultural production, processing, storage and marketing as well as research and development imperative. In light of this, the Federal Ministry of Agriculture and Water Resources developed the 5-point agenda for Agriculture and National Development as an implementation roadmap in the short and medium-term towards the attainment of the objectives of the National Food Security Programme (NFSP).

The strategic objective of the 5-point agenda is to achieve the targets defined in the larger planning framework of the 7-point agenda, NEEDS II, CAADP, the MDGs and vision 2020. The 5-point agenda focuses on the following five key programmes:

1. Developing Agricultural Policy and Regulatory System (DAPRS) which aims at ensuring sound agricultural policies and regulatory frameworks while its objectives are to review and reform key agricultural policies and framework and to communicate the new or revised policies and framework.
2. Agricultural Commodity Exchange Market (ACCOMEX) which aims at establishing agricultural commodity exchange markets with the objective of achieving efficient marketing and price information system.
3. Raising Agricultural Income with Sustainable Environment (RAISE) which aims at addressing the challenges of infrastructure development and infrastructure for sustenance of the environment (rural energy, rural markets, transport and health) and the focus is the provision of necessary infrastructure to enhance agricultural productivity in addressing the issues concerning small and medium scale agri-business in Nigeria.
4. Maximizing Agricultural Revenue in Key Enterprises (MARKETS) which aims at improving the competitiveness of value-added product leading to increased market through private-sector led and market-driven growth and development.
5. Water, Aquaculture and Environmental Resource Management which aims at achieving intensified aquaculture production systems, sustainable

conservation through construction of small dams, irrigation facilities and gaining “carbon credit” through afforestation.

2.1.3 Vision 2020, 7-point agenda, CAADP and the 5-point agenda

The goal of the Comprehensive Africa Agriculture Development Programme (CAADP) in Nigeria is to support the development of a comprehensive agriculture development component under the seven point agenda of the president and the 5-point agenda of the FMAWR which are aligned with the CAADP objectives and principles that Nigeria and other African countries have collectively defined as part of the broader agenda of the new partnership for Africa’s Development (NEPAD). While the vision 2020 provides long term guidance on a broad number of national level objectives, the 7-point agenda and NEEDS II are the medium term programmatic frameworks seeking to integrate development efforts across key economic sectors. CAADP combines the long-term outlook of the vision 2020 with the programmatic focus of the 7-point agenda and NEEDS II applied to the agricultural sector. The 5-point agenda and the NFSP, on the other hand, have a strong short term, operational nature and a primarily subsectoral focus on the agricultural sector. They define and pursue the implementation of the short-term investment and policy measures that are required at the sub-sectoral level to achieve the sector wide objectives specified in the 7-point agenda and CAADP frameworks. In Nigeria and West Africa as a whole, the CAADP initiative is being implemented in line with the ECOWAS Common Agricultural Policy (ECOWAP) which is a long-term plan to achieve sustainable food security in West Africa.

2.2 Rice Production

Nigeria possesses huge untapped potential for irrigated rice development. There is an estimated 3.14 million hectares of irrigated land out of which less than 50,000 hectares is currently under rice irrigation. Increase in population and urbanization has continued to drive growing demand for rice in Nigeria coupled with consumer preference for higher-quality milled rice. Several analyses have shown that paddy production is a very profitable business. A fully costed hectare using market rates for inputs and all labor and applying best practices that should yield 3.5 – 4 MT of paddy is nearly ₦130,000, yielding a profit of about ₦70,000 per hectare (Grant *et al*., 2009). If the farmer is able to significantly reduce his or her labour costs, either by using family members, the returns to the household increase. Farmers who are using the more sophisticated production technologies in fadama areas and are linked into regular markets are significantly more profitable than farmers who are using traditional production technology.

CARD (2012), identified traditional rice-cropping problems which include the use of low quality, mixed varieties seed leading to degradation over time in quality, high cost of fertilizer and difficulty in procuring fertilizer in the appropriate amount at the appropriate time, low level of knowledge and training, lack of irrigation facilities, lack of storage facilities, poor pests and disease management, ineffective farm implements, lack of access to institutional and infrastructural support and low farm mechanization. However, according to IRRI (2012), rice production can generally be divided into seed selection, land preparation, crop establishment, water

management, nutrient management, crop health, harvesting and post harvesting operations.

2.2.1 Seed selection

Choosing a suitable variety of rice to grow that suits the environment it will be grown in and ensuring the seed chosen of that variety is of the highest possible quality is the essential first step in rice production. Good quality seed can increase yields by 5-20%. Good seed is pure (of the chosen variety),full and uniform in size, viable (more than 80% germination with good seedling vigor), and free of weed seeds, seed borne diseases, pathogens, insects or other matter. Using good seed leads to lower seeding rates, higher crop emergence, reduced replanting, more uniform plant stands, and more vigorous early crop growth. All of these factors contribute to higher yields and more productive rice farms.

2.2.2 Land preparation

The aim of land preparation for rice production is to place the soil in the best physical condition for crop growth and to ensure that the soil surface is leveled. Land preparation involves plowing and harrowing to “till” or dig up, mix, and overturn the soil, and levelling.

2.2.3 Crop establishment

The two main practices of establishing rice plants are transplanting and direct seeding. Transplanting is the most popular plant establishment technique across Nigeria. Transplanting is when pre-germinated seedlings are transferred from a

seedbed to the wet field. It requires less seed and is an effective method to control weeds, but requires more labor.

Direct seeding is when dry seed or pre-germinated seeds are broadcast by hand or planted by machine.

2.2.4 Water management

Cultivated rice has a semi-aquatic ancestry and is therefore extremely sensitive to water shortages. When the soil water content drops below saturation, most rice varieties develop symptoms of water stress. Sound water management practices are needed to use water wisely and maximize rice yield. To ensure sufficient water, most rice farmers aim to maintain flooded conditions in their field.

2.2.5 Nutrient management

Ensuring that the rice plant gets the exact nutrients it needs to grow is of great importance. This is because each growth stage of the rice plant has specific nutrient needs. Farmers are able to conserve soil organic matter and also receive free input of nitrogen from biological sources because of prolonged flooding in rice fields.

2.2.6 Crop health

The rice plant has a wide array of enemies in the field. These include rodents, harmful insects, viruses, diseases, and weeds. Avoiding conditions that allow pests to adapt and thrive in a particular ecosystem helps to identify weak links in the pests life cycle and therefore what factors can be manipulated to manage them. Farmers

manage weeds through water management and land preparation, by hand weeding and in some cases herbicide application.

2.3 An Overview of Rice Processing Technologies

Rice processing according to NCRI (2008) involves four (4) main operations, threshing, winnowing, parboiling and milling. But in its simplest term, rice processing refers to all processes from harvesting rice to consumption and /or marketing. The processes consist of two inter-related phases: primary processing and secondary processing.

The main processes in the primary processing are harvesting, threshing, cleaning, drying and milling. In some cases, where parboiling is practiced, parboiling becomes part of the main processes. Intermediate processes of in-field handling, transport, storage occur between the main processes and are critically affecting quantity of losses and quality of the product. Further, by definition, it will also include the secondary processing which aims to add value to the product. This includes product development and bye-product utilization; although bye-product utilization is also addressed in the primary processes of harvesting and threshing. The product from primary processing serves as the raw materials for secondary processing. It is therefore necessary that they should be supplied in the right quantity and quality at the right time. Marketing is a function which occurs in both phases.

The quantity and quality of final milled rice depend on the efficiency of farming management, field operations and post harvest operations (Halos, 2007).

2.3.1 Pre- harvest operations

The farming management and field operations as well on the post field operation determine the quantity and the quality of milled rice. According to NRI (1991) decisions related to production of rice are important in attaining the quality desired for the processed grain. For example, the choice of a variety to be planted determines the stand, stature (tall or short), maturity (early to late), grain to straw ratio (high to low), shattering characteristics (easy to difficult), husk tightness (loose to tight), amylase content (low to high), grains size (short to long), grain length to width ratio (small to large), panicle stature at maturity (erect to drooping), and other characteristics pertinent to that variety. These characteristics in turns become factors influencing the ease, efficiency, grain loss magnitude, and choice of harvesting and threshing technology. They also affect the rate and quality of the drying process and the quality of dehusked rice (brown rice) and eventually the total recovery and the quality of milled rice. Sometimes, high management is required to monitor planting in order to prevent varieties becoming mixed; on the other hand, varieties are sometimes deliberately mixed

to produce special characteristic, such as consistency of flavour, which cannot be found in a pure variety (Halos, 2007).

Proper timing is important in harvesting the crop as losses could be incurred if rice is harvested too soon or too late. Immature grains due to too early harvest result in high percentage of broken and low milling recovery. Delayed harvesting exposes the crop to insect, rodent and bird, in addition to increase risk of lodging and grain shattering. The idea is to be within the window of optimum harvest period.

Ray (2001) stated that, the indicators of optimum harvest of the rice grain are as follows: The variety has reached the particular date of maturity or number of days after heading, 28-34 days. The field should be drained about 7-10 days before this maturity date; Eighty percent (80%) of the grains or the upper portion of the panicle has changed from green to straw colour; At least 20% of the grains at the base is already in hard dough stage; Grain moisture content ranges from 21-24%; The hand- dehulled grain, as indicated by daily tests near the projected harvest day, is clear and hard.

2.3.2 Harvesting

Harvesting includes numerous operations, including: cutting the rice stalk; reaping the panicles; laying out the paddy – on- stalk or stacking it to dry; and bundling for transport. The sequence of manual harvesting, field drying, bundling and stacking in traditional systems can cause losses of between 2 and 7 percent (NCRI,2008). Harvesting of rice in Nigeria is greatly under-mechanized which leaves farmers struggling with high and sometimes unaffordable labour wages. In some instances, there is outright lack of labour to meet harvest schedule. Late and untimely harvesting, which is due to lack of available labour and excessive competing demand for existing labour, results in poor quality paddy harvest. In addition, high rate of broken rice due to weather extremities is prevalent (CARD, 2009). There are several method of harvesting rice, the most common are still the traditional manual methods which includes:-

a. Panicle reaping by knife

b. Long stalk cutting by sickle

The modern mechanical method can also be used depending upon the custom and the suitability of the machine to the soil conditions and the crop being harvested, the local custom, affordability of the machine and the other socio-economic factors (Sahay, 2009).

a. Reaper binder;- the machine cuts and bundles the stems together and lays them in the field in one operation.

b. Combine:- It is a self propelled machine which does all operations including threshing in one operation.

c. Stripper harvester:- This is an innovation from the international rice research institute which adopted the rotary stripping comb principle developed by the silsoe research institute in silsoe, uk.

The following situations hinder the adoption of mechanized harvesting methods.

a. Low income, reluctance to change traditional methods;

b. Small land holding, poor water control and lack of access roads to the field.

c. Excessive moisture content at harvest time, uneven ripening and high shattering.

d. The high cost of imported equipment and the requirement of good machinery management which compete with relatively low cost labour.

2.3.3 Threshing

During threshing, the paddy grain is detached from the panicle, an operation which can be carried out either by rubbing, impact or stripping. Rubbing may be done with trampling by humans, animals, trucks or tractor; however, the grain becomes damaged. Mechanical threshers adopt mainly the impact principle, but there is also a built-in stripping action. With a paddy thresher, the un-threshed paddy may be either held or thrown in. in the 'hold -on- type', the panicle in held against the rotating cylinder while spikes or wire loops, grains are separated by the impact of the threshing drum. In a 'throw-in-type' thresher, the whole paddy stalks are fed into the machine and a major portion of the grain is threshed by the initial impact caused by bars or spikes on the cylinder. The traditional threshing methods employed in Nigeria introduce impurities into the rice and are inefficient and labour intensive. Manual threshing involve beating the panicle with a stick or flail device. The method contaminates grains with sand and stones because it is normally done on bare ground while all threshed grain are swept with the sand and other contaminants into bags. According to IRRI (2000), high losses can occur during threshing for various reasons:

- In manual threshing by beating, some grains remain in the bundle panicles and a repeat threshing is required.

- Grain is scattered when the bundles are lifted just before threshing.
- Grain can stick in the mud floor.
- Birds and domestic fowls feed on the grain.

2.3.4 Cleaning

This is an important operation and highly recommended not only on a large and medium commercial scale, but also on small scale. It consists of the separation of undesirable materials, such as weed, seeds, straw, chaff, panicle stems, empty grains, damaged grains etc. The amount of impurities in the paddy reflects to some extent the care applied during harvesting, threshing and handling. (Halos, 2007).

In developing countries, farmers clean the paddy straight after manual threshing, first, they use hand-raking and sifting to remove straw, chaff and other large and dense materials, then winnowing. The effectiveness of the method depends on the wind speed and is very slow. The absences of effective cleaning devices often result in poor quality milled rice in term of contaminants. Stones and other hard object and mixtures in the paddy also shorten the life of the milling machinery. The milling recovery is usually low.

In commercial large and medium scale rice mills, scalping is the first stage in the industrial process where most foreign matter is removed to reduce dry cost, eliminate clogging or damage to conveying equipment and prevent paddy deterioration during storage due to high moisture spots of non grain organic matter. The second cleaning stage occurs after storage prior to milling process to remove the remaining foreign matter that could damage the milling machinery and affect the grain quality or grade of milled rice and therefore, its market value. Cleaning devices may include vibrating or rotating sieves, aspirators, destroyers and magnetic separators.

A hand or pedal operated blower may be used. Alternatively, an engine-powered fan is used and can simultaneously perform grading and cleaning.

2.3.5 Drying

Paddy as a living biological material absorbs and gives off moisture depending on: paddy moisture content, relative humidity of the air and temperature of the surrounding atmosphere. In general, paddy is harvested with moisture content of 24 to 26 percent (NCRI, 2008). At this moisture content at harvest, paddy has a high respiration rate and is very susceptible to attack by micro- organisms, insect and pests. According to Ray (2001), the heat evolved during the respiration process is retained I the grain and in the bulk because of the insulating effect of

the rice husk. This heat increases the temperature of the grain resulting in increased mould growth, fungi, insects and pests infection, which increases the quantitative loss and qualitative deterioration. Grains become ranacid, mouldy, yellowish, insect and pest infected. Drying is the most important method in minimizing post harvest losses, since it directly affects safe storage, transportation, distribution and processing quality. Therefore, harvested grain with high moisture content must be dried within 18 percent for temporary storage of 2 weeks when it is not possible to dry any faster. Delayed drying may result in non-enzymatic browning (stack-burning), microbial growth and mycotoxin production in parboiled rice (NRI, 1991).

Small rural farmers use tarpaulins, bare ground, by roadside or used plastic bags for paddy sun-drying. A temperature of 43^{o}C is recommended for drying paddy for seeds and this can be achieved with shade drying (NRI, 1991). Higher temperatures can kill the germ. However, mechanical dryers can also be used on commercial scale, the choice of drying system depends on several factors; drying capacity requirement, ease of installation, costs, portability and heat source.

2.3.6 Parboiling

Parboiling is a heat treatment given to paddy rice before drying and milling. (NCRI, 2008). The paddy grains are mainly composed of polygonal starch granules. The voids or intergranular spaces are filled with air and moisture. Due to these voids cracks develop and it causes breakage during milling. The breakage maybe reduced by gelatinizing the starch. During gelatinization process starch swells and fill the voids.

During soaking of paddy, water penetrates into starch granules and result in swelling of the grains. In heating, the energy weakens the granules structure and more surfaces become available for water absorption and result in irreversible granules swelling. This phenomenon is called gelatinization of starch (NCRI, 2004).

The temperature at which the gelatinization take place is known as gelatinization temperature and it is specific for particular variety in the near hood of 70^{0} C. Parboiling makes rice easier to process by hand, improves its nutritional profile, and changes its texture. The starches in parboiled rice become gelatinized, making it harder which enables it to stand the impact of milling resulting in high head rice recovery. The heat treatment stabilizes the lipids making rice less prone to enzyme-driven oxidative deterioration (IRRI, 2000).

During parboiling, the nutrients, especially thiamine, are absorbed into the grain from the bran, so that parboiled white rice is nutritionally similar to brown rice. Parboiled rice takes less time to cook, and the cooked rice is firmer and less sticky. These important advantages have made parboiling a very popular rice

processing activity. In Nigeria, most (over 90%) of the rice produced is parboiled.

Sahay and Singh (2009), enumerated the disadvantages of parboiling as follows:-

a. The heat treatment during parboiling destroys some natural anti- oxidants; hence rancidity developed in parboiled rice during storage is more than that in raw rice.

b. Parboiled rice takes more time to cook than raw rice.

c. Parboiling process needs extra capital investment.

d. Parboiling add to the cost of drying.

e. As paddy is soaked for a longer time, it may be attack by spores which may cause health hazard

f. More power is required for polishing of parboiled rice.

ii. **Steps in Rice parboiling**

Before parboiling, the rice must undergo pre-cleaning and in most cases, especially in modern plant, water winnowing is done, where the paddy is poured inside a pool of water, turn thoroughly and allow to settle down. The immature grains, impurities and chaffs float and they are sifted with basket. The clean grains are then taken for parboiling. There are three major steps in rice parboiling apart from pre-cleaning. These are: soaking, steaming and drying (NCRI, 2000).

Theoretically, soaking of paddy can be done at or below its gelatinization temperature. The lower the temperature used, the slow is the process of soaking and vice versa. Soaking period can be reduced by subjecting the paddy to vacuum for a few minutes before soaking and/or soaking under pressure in hot water. Heat of gelatinization of starch is supplied by saturated steam. Parboiled paddy may be dried in the shade or in the sun or with hot air. Shade drying takes longer time but gives excellent milling qualities. Rapid drying in sun or with hot air causes higher breakage during milling. The most convenient practices is to dry in two passes with a tempering period in the moisture range of 15-19% (wet basis)(NCRI,2004).

2.3.7 Rice milling

Small mills dominate the processing of Nigeria domestic paddy. However, small mills have the disadvantage of a high level of broken rice rate and poorer milled quality. The profit margins for traditional milling are quite small. Small mills will charge about ₦250 for a 100kg bag of paddy but heavy duty mills may charge up to N500 for 100kg bag of paddy. A small mill can process up to 15 bags of 100 kg weight in a day for a total sales of ₦3,000 from which electricity, diesel, spare parts and labour costs must be subtracted. The small margin is dis-incentive the investment of marginal improvements in rice processing capacity by small millers. Recently, two new large-scale industrials mills owned by major multi-national food companies (Olam and Veetee) began operation in Nigeria. Each mill has the potential to produce cleared and polished rice that can compete with imported products. There are also some large scale mills in Sokoto, Badeggi and Onitsha established by state governments but they are barely operation due to lack of spare parts.

2.3.8 Storage

The traditional means of storing rice at the farmer level is in bags within a room in the farmers dwelling. This however, results in quality degradation due to inadequate storage temperature control and rodents invasive activity. This kind of in-attention to quality control is linked to the low marketing price for traditionally stored rice.

2.3.9 Post-harvest processing constraints

Due to scarcity of machinery to help grow, process and distribute the product, rice post-harvest losses account for 15-20% of the market value of production. Post harvesting constraints include; lack of access to improved technologies, high costs of energy for parboiling, poor storage facilities, lack of adequate funding, lower output quality (post processing) and limited government incentives. The biggest problem in post harvest processing is unhusked and milled rice quality control. Poor quality of domestic rice is caused by late harvesting, improper drying and sorting methods which allows foreign matter and small peddles to get mixed with the rice and poor quality of mills and storage. With the establishment of the two large scale processing mills, Olam and Veetee, the main challenges are getting enough quality rice paddy to feed the mills.

2.3.10 Rice marketing

The marketing structure includes producers (farmers; agricultural cooperatives), importers, wholesalers, retailers, brokers, collectors and shippers, parboilers, millers and the end consumer. Marketing of domestic rice is subject to a complex distribution structure involving numerous levels of middlemen and rice merchant. Rice is supplied primarily to the immediate and adjacent urban

markets. Large scale inter-state transfer of produce is only common during harvesting period. Accordingly, marketing of domestic rice heavily depends on the season. Marketing of imported rice however involves an organized distribution network geared to consumer taste while imported rice varies in quality, it is all of a higher quality than the domestic rice. Margin analysis; analysis shows that each marketing step from the mill to the consumer is generally a low margin (less than 15 percent), high turnover business. Traders buy 100kgs at the main processing clusters in volumes of 1-4 MT and then bring them to the end markets for wholesale and/or retail. The end market price of domestic rice is heavily dependent on the price of imported rice. Usually, traders are able to sell domestic rice at roughly 15-20 percent below the cost of imported rice. This price margin is transmitted back to the mills where the price of milled rice is set.

2.3.11 Marketing constraints

One constraints to marketing of agricultural produce is weak market information service. Lack of market information creates unequal playing field between middlemen and farmers. This negatively affects the term of trade for small holder farmers and raises market transaction costs which lead to poor integration of markets across space and time (Emodi and Madukwe 2008).

Nigeria tariff policies also affect marketing of domestic rice in the country. The lifting of imported rice ban and the adoption of inconsistent and flexible tariff rates has resulted in aggressive participation of private sector rice importers in the marketing sector, highly competitive rice markets, significantly increasing imported rice quantity and changes in consumer taste in staple food. Other issues affecting Nigeria's rice value chain include worsening profitability in rice cultivation due to rising chemical fertilizer price and agricultural labour wages, switching from rice cultivation to other crops, lack of access to institutional credit on the part of small scale rice marketing agents and small farmers, inadequacy of modern storage and processing facilities, absence of precise scale system in determining rice quantity and poor commercial linkages of marketing agents.

Other constraints include; policy inconsistency: Agricultural policies in Nigeria have been inconsistent while abandoning of programmes is not uncommon. The policy process is made more complex by the multiple policies that exist at National, State and Local levels that can often run counter to one another. The lack of predictability surrounding Nigeria's agricultural policy framework makes investment in the value chain high risky. Similarly, government credibility is further marred by poor policy implementation due to corrupt practiced by some government officials and bureaucrats. Another constraint is the poor state of infrastructure in the country. The national road network does not effectively reach small farms, which hinders the development of efficient trucking and transport system for agricultural marketing and agri-business development.

Nigeria's ports infrastructure and customs facilities are undersized and over taxed while the unreliability of the power supply remains a major issue. These deficiencies contribute to the high production costs and further undermine the profitability of agriculture.

Another constraints is poor access to finance, there is relatively little finance being provided b Nigeria financial institutions into the rice value-chain. The government run NACRDB or Bank of Agriculture was set up to provide financing to farmers, farmers organizations and farm produce merchants. However, NACRDB micro credit is not targeted at the independent farmers. Rather, it is been carried out by international agency and NGO sponsored groups. Other conditions to access funds include 8% interest rate per annum, lending period of 2 years or less, collateral of 10% deposit and a guarantee by farmer group. Another alternative to government bank credit are commercial banks. However, their interest rates are higher usually up to 30% when all charges are taken into consideration and collateral discourage most of the rural small holder farmers from accessing commercial bank loans. Another constraints is low investment in Agricultural Research which is primarily funded through the Federal Government budget at about 0.02% of GDP. Some of the challenges affecting agricultural research system in Nigeria include poor funding of the research institutes and weak or poor coordination within the Nigerian agricultural research community resulting in duplicating of efforts.

Similarly, in Nigeria, extension services are delivered mainly through government agencies, usually the ADPs. Due to underfunding, the ADPs have no resources to train their staff to stay current with good production practices or travel to the farming areas to work directly with farmers. Other problems with public agricultural extension in Nigeria include chronic under investment, poor coordination between different levels of government and poor accountability to farmers and processors (World Bank, 2004).

iii. Traditional rice processing technology

In Nigeria, the paddy is soaked in water for about 8-12 hours depending on the rice variety and the soaking temperature ranges from $80^{o}C – 90^{o}C$ (NCRI, 2000). The paddy is then turned into large clay pots for steaming. The pots have a false bottom to allow heat to penetrate through. The rice paddy is allowed to steam for about 30 – 45 minutes, after which the paddy is dried before milling.

In another traditional method, the process consist of soaking paddy in water at room temperature for 24-48 hours or more, steaming in kettles under atmospheric pressure and drying under the sun. in a single boiling method, paddy is soaked in ordinary water for 24-72 hours and then steamed. In double boiling method, steam is first inject into raw paddy in the steaming kettle before soaking, hot paddy raises the temperature of soaking water to $45\text{-}50^{o}C$ which helps to reduce the soaking time to 24 hours. Thereafter, soaked paddy is steamed, sometimes, the soaking water is heated to abut $50^{o}C$ then the raw paddy is put into it and in this case first steaming is not required.

2.4 The Improved Rice Processing Technology

The Central Food Technological Research Institute, Mysore, India and the National Cereal Research Institute, Badeggi, Nigeria have developed similar improved rice parboiling method which involved water heated to about 85^{o}C and the paddy is introduced and vigorously turned so that the light grains and chaff float and can be skimmed off. The paddy is then soaked for 3 to 4 hours at 65^{o}C to 70^{o}C in a cylindrical tank. Passing vertically into the tank is a slotted steam pipe so that the mass of paddy may be steamed throughout in the shortest possible time. The water is drained from the paddy and steam introduced. By the time the steam emerges from the top, the grain is sufficiently and uniformly parboiled. It is then dried and milled.

In another version called the schule process, which was originated by a German rice machinery manufacturer, steam is not applied directly to the paddy but is used to heat the water. The paddy is put into a pressure tank and is first soaked for about 120-160 min in water at medium temperature while the water is kept in circulation. When the rice has reached the temperature of the soaking water, the water supply is turned off, and hydrostatic pressure (4-6kg/cm2) is applied by admitting compressed air.

The second cooling period starts by lowering pressure and readmitting the water, which has been heated to a very high temperature to ensure that the paddy, with a moisture content of about 40%, is carried by a vibratory conveyor to a pre-drier designed to take a full batch of wet paddy. Here, the moisture content is reduced and the product is then unloaded into two or more column driers, where drying is continued until a moisture content of 13% is reached. The dried paddy is then milled.

Similarly, in the parboiling process developed at the University of Jadavpur, India, the operations are fully automatic. The average processing time is about 5-6 hours. Steeping is completed in water at 60-70 degree Celsius within 2-3 hours, where as steaming requires only from 3-5 minutes. The high temperature of the water and the short steeping time contribute to the production of good quality parboiled rice. After steaming, the paddy is rapidly cooled. Drying takes place in a rotary, steam-jacketed, high-temperature air dryer to 13% moisture. The rice is then milled (NCRI, 2009).

In another method called pressure parboiling method, developed at Tiruvarur in Tamil Nadu, the parboiling is achieved by penetration of moisture into paddy in the form of water vapour under pressure. This results in gelatinization of starch of the kernel. The paddy is soaked for 40 minutes at 85-90^{o}C. Thereafter, it is steamed under pressure for 18 minutes. The water vapour which penetrates the

kernel drives out entrapped air. It is reported that the whole process is completed in 1-to 1.5 hours. The rice obtained by this method has a pleasing and slightly yellowish uniform colour. Reduced soaking period of paddy is the main advantage of this method. It was also observed that such parboiled paddy has better shelling efficiency, has more fat in bran and increased storage life of rice grain (Sahay & Singh 2009).

2.4.1 Description of the improved rice processing technologies disseminated

1. **200kg capacity rice parboiler/containers:** This is a cylindrical container made of 0.7mm galvanized steel of 1000m diameter. It has a removable cover and false bottom. Two handles are attached at near the top to facilitate easy carrying. There are two outlets one slightly above the other for evacuation of water. During operation, all outlets are closed, after soaking, the upper outlet is opened to discharge the hot water, when its stops dripping, the remaining water inside the parboiler is enough for steaming the soaked paddy inside the parboiler and after steaming, the lower outlet is opened to discharge the remaining water.
2. **Local destoning sieves:** This is rectangular sieve made up of a wooden frame and handle. There is wire mesh of 1mm diameter supported by another thicker sieve of 10mm diameter. It is operated by shaking the clean paddy to remove sand and little particles that can pass through the openings.
3. **Stitching machine:** This is an electrically driven device meant to stitch bags using threads.
4. **Weighing slab:** This is a mechanical weighing device that reads a given quantity of weight. desired weight can be measured by accurately using the device.

5. **Packaging materials:** These consists of a transparent polythene bags which has the women groups name/contact address and the weight of the produce 5kg and 10kg bags.
6. **Rice mill:** This is an Engleberg huller. The purpose of the machine is to remove the husk from the paddy grain with minimum damage to the bran layer and as far as possible not to break the rice grain. The adjustment of the machine depends upon the variety and uniformity of grain. Its uniformity is necessary for best performance of equipment.
7. **Concrete drying slab or tarpaulin:** This is a drying flat form which is clean and free from all contamination and easy to sweep and turn rice easily for drying. It is made of concrete and the surface is smooth not rough for easy cleaning and collection of dried paddy. It can be substituted by strong and thick tarpaulin.

2.5 Adoption of Rice Processing Technologies: Factors Affecting Adoption

The adoption of technology goes through five stages according to Van den ban and Hawkins (1996). These are awareness stage, interest stage, evaluation stage, trial stage and adoption stage. The above adoption process has the following deficiencies according to Rollings and Pretty (1996), these are;

-The process is viewed as always resulting in adoption whereas in reality rejection of the innovation is also possible.

-The process gives an impression that the steps always occur in sequential order whereas some of the stages may either be skipped or occur simultaneously.

-Evaluation actually occurred throughout the process rather than forming a stage.

In another perspective by Adedoyin (2005), the process of adoption can be viewed through the following four basic stages:

-Knowledge - awareness and understanding for the first time.

-Persuasion – when the individual develops an attitude toward the innovation.

-Decision – engagement of positive activities which may lead to eventual acceptance.

-Confirmation – expectation of reinforcement in the form of satisfaction or realization of goal.

Research findings carried out by some scholars and Institutes on technology adoption in developing countries on factors that influenced technology adoption can be grouped into the following three broad categories (Feder *et al*., 1985): (1) factors related to the characteristics of producers; (2) factors related to the characteristics and relative performance of the technology and (3) institutional factors. The factors related to the characteristics of producers include educational level, experience in the activity, age, gender, level of wealth, farm size, labour availability, risk aversion, etc. The factors related to the characteristics and performance of the technology include food and economic functions of the product, the perception of individuals of the characteristics, complexity and performance of the innovation, its availability and that of complementary inputs, the relative profitability of its adoption compared to substitute technologies, the period of recovery of investment, the susceptibility of the technology to environmental hazards etc. The

institutional factors include availability of credit, the availability and quality of information on the technologies, accessibility of markets for products and inputs factors, the land tenure system, and the availability of adequate infrastructure etc. Ekong (2008) found that mean age of the present Nigerian farmer is between 45 to 50 years and there is no association between age and the adoption behavior of these farmers similarly, there is a positive association between literacy and adoption of innovations but no significant relationship between adoption of innovation and formal schooling.

Also there is a positive relationship between level of income and adoption of innovations. Idrisa et al (2008) found higher rate of adoption due to availability of the recommended practices disseminated. In another research by Yusif (2009), rate of adoption of improved technologies was found to be relatively higher because the technologies were easy to operate.

2.6 Constraints Faced by Women in Technology Adoption

Ayoade and Akintonde (2012) identified constraints faced by rural women in adoption of agricultural innovation which include failure of extension workers to reach them, lack of incentive for adoption of innovation, limited access to credit inputs and lack of access to membership in cooperative and other rural organizations. Empirical study have shown that some because of their habit and apathy are resistant to change, that is , they cannot agree to accept any agricultural innovation which may definitely change or affect their agricultural system. In another study conducted by Ndah (2008) and Sulo et al (2012), it was found that, Lack of production skills, unstable market price, insufficient finance, inadequate supply of innovation and high cost of innovation were among the women constraints in technology adoption.

Similarly, Ekong (2003), stated that, adoption facilitate when farmers have access to factors like extension service, credit facilities, farm inputs and other technological

innovations. Benjamin (2010), found that credit from informal institutions was the major influencing factor in adoption of recommended cassava technologies. According to Ani et. al (2008), several factors positively influence the adoption of agricultural technologies. These include the needs of the farmers, their level of awareness, level of income and education. Ngoddy (1984) argues that most of the technologies were designed without taking proper cognizance of the socio-economic realities in Nigeria. He maintains that the technologies are expensive, given the inflationary trend in the country and they are beyond means of most small-scale women farmers.

Nigeria's small scale women farmers and food processors also suffer from high rate of illiteracy. This makes it even difficult for them to comprehend simple instructions on food processing and preservation, especially in cases involving application of chemicals. Ekong, (2003) is of the opinion that most rural women do not understand even a display of instructions by line diagrams.

Cultural factors also played a crucial role in constraining women from technology adoption. Rural Scople (1988) reported that most men rather than embrace the new yam pounding machine designed to ameliorate the drudgery in women's domestic chore still insist on the manual and tedious traditional methods of preparing pounded yam. According to Akinrele (1970), access to credit by processors is pivotal in ensuring the success of many businesses. However, many processors experience difficulties with security credit and it is one of the most common constraints.

In this study, membership of Association would play a crucial role in adoption of the technologies since it was only those within the association that were trained

and assisted. Similarly, education is expected to play a role because despite most of them did not go to formal schools, yet they were trained on the technologies and have good practical demonstration of the equipment. Another important factor that would contribute to adoption of the technologies is household size. Most households that have enough family labour do not adopt technologies easily, they tend to resist even though it would reduce drudgery and save time for them, it takes time unless the technology have a very high relative advantage. Extension contact is expected to play a vital role in technology adoption. Constant visits by the extensions agent to teach and encourage the processors would speed up the adoption process. Similarly, lack of it would slow down the speed at which the technology would be adopted.

Access to credit, it is expected that, those processors that have access to credit would adopt the technologies faster than those that do not have access to the credit because they would be in the best position to own and utilize the equipment fully, since they have enough capital to buy raw materials also.

Age is expected not to contribute to the adoption of the technologies because majority of the processors are adult above the age of 30.

Processing experience is also not expected to play a crucial role in adoption of the technologies because almost 100% of the women processors are experienced in the business.

2.7 Theoretical Framework

2.7.1 The adoption and diffusion theory

The diffusion of innovation theory is concerned with the manner in which a new technological idea, artifact or technique or a new use of an old one, migrates from creation to use (Arnie, 2012). According to diffusion of innovation theory, technological innovation is communicated through particular channels, overtime, among the members of a social system (Apperson and Wikstron, 1997). Diffusion of innovation theory purports to describe the patterns of adoption, explain the mechanism, and assist in predicting whether and how a new invention will be successful (Mahajan et al, 1990). According to Rogers (2003), he defines the term diffusion of innovations as a process by which an innovations spreads. The diffusion involves four essentials elements, the innovation, its communication from

one group to another, a social system within which this process occurs and the time period over which the process is affected.

Rogers (2003) presented four adoption/diffusion theories:

i. **Innovation Decision Process Theory:** Potential adopters of a technology progress over time through five stages in the diffusion process. First, they must learn about the innovation (knowledge); second, they must be persuaded of the value of the innovation (persuasion), they then must decide to adopt it (decision); the innovation must then be implemented (implementation) and finally, the decision must be reaffirmed or rejected (confirmation). The focus is on the user or adopter.

ii. **Individual Innovativeness Theory:** Individuals who are risk takers or otherwise innovative will adopt an innovation earlier in the continuum of adoption/diffusion.

iii. **Rate of Adoption Theory:** Diffusion takes place over time with innovations going through a slow, gradual growth period, followed by dramatic and rapid growth, and then a gradual stabilization and finally a decline.

iv. **Perceived Attributes Theory:** There are five attributes upon which an innovation is judged: that is can be tried out (triability), that results can be observed (observability), that is has an advantage over other innovations or the present circumstance (relative advantage), that it is not complex to learn or use (complexity), that it fits in or is compatible with the circumstances in which it will be adopted (compatibility). The theories were applied to determine to what extent the technologies on improved rice processing reaches

the farmers, similarly, identify rate of adoption and factors influencing the adoption of the improved rice processing technologies in the study areas.

According to Odoemenem and Obinne (2010), the distinction made between adoption and diffusion concepts is that "adoption is a concept which refers to the acceptance and continuous use of an idea or practice by single unit of a potential audience; while diffusion on the other hand is a concept which refers to the spread of idea, or practice through the whole of the potential audience or social systems. Diffusion theory offers a rich perspective on innovation and the forces that drive adoption of innovations and those that restrain them. Its theoretical under pinnings have been demonstrated in a number of fields (Arnie,2012). The process of diffusion is interesting in the field of technology due to the applications and the fact that technology diffusion may differ due to the existence of technology clusters and the education, income and need for innovativeness that drives it (Mahajan, Muller and Bass, 1990).

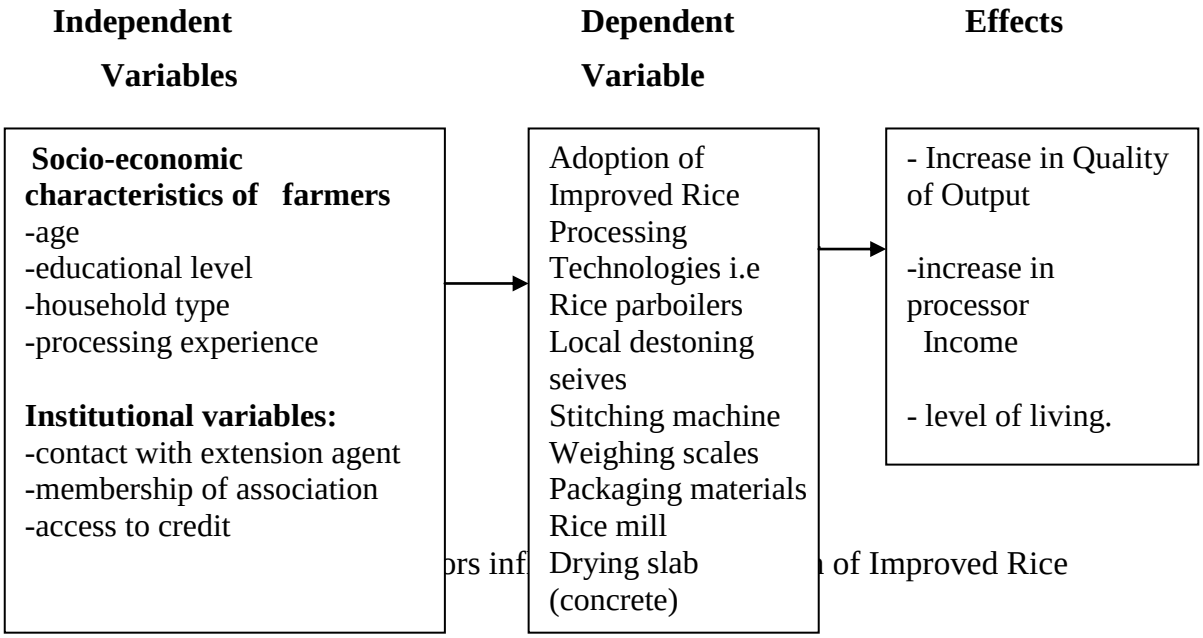
The categories of adopters according to Rogers(2003) are: Innovators, Early adopters, Early majority, Late majority and Laggards.

2.7.2 Conceptual model

According to Adebayo and Okunaye (2004), models have been used in research as primary tools for organizing knowledge gained in experimentation, it is a figurative expression of relationships among variable. Similarly, Akin (1970) defined model as simply " an attempt to classify the major elements of an entity or a phenomenon

with regards to their functions and interrelationships in order to observe more closely how the elements function within the entity. Furthermore, Asika (2003) reported that these relationships and functions can be represented schematically or mathematically.

In the model shown in the figure 1, socio-economic characteristics of farmers and institutional variables (age, educational level, household size, processing experience, contact with extension agent, access to credit, and membership of social group) affect the adoption of the improved agricultural technologies and if they have positive effect, there would be increase in output, increase in farmer income and then improvement in the quality of life.



ors inf of Improved Rice

CHAPTER THREE

METHODOLOGY

3.1 **The Study Area**

Jigawa State is located between latitudes 11^{o}N to 13^{o} N and longitudes 8^{o} E and 10.15^{o} East. With a population of 4,384,649 persons, (NPC, 2006) and 5,322.746 persons projected from 2006 census figures at 2.8% growth rate. It covers a land of about 22,410 square kilometers. Most part of the State lies within the Sudan vegetation zone. There are traces of Guinea Savannah on some parts of the southern borders. The mean daily minimum and maximum temperatures are 19^{o}C and 35^{o}C respectively. The rainy season lasts between May to September with a range of 1000mm-2000mm.

The major tribes are Hausa, Fulani and Beri-Beri. Islam is the predominant religion. About 70% of the total land mass of Jigawa State is cultivable during the rainy season.

Popular rain-fed season crops include; millet, sorghum, maize, cowpea, rice, groundnut, sesame, cotton and watermelon. The State is blessed with vast flood plains popularly known as Fadama lands. These flood plains are characterized by the availability and easy access to both surface and underground water. The estimated land area under this category is about 150,000 ha, 80% of which is cultivable under irrigation during the dry season between November and April. Major crops grown during dry season are: Tomatoes, onion, wheat, lettuce, carrots, maize, sugarcane and pepper.

Animal husbandry is very common in the state with about 80% of the farm families keeping livestock. Common livestock kept include: goats, sheep, cattle, donkeys,

horses and poultry. Communities along rivers engage in fishing and fish processing activities.

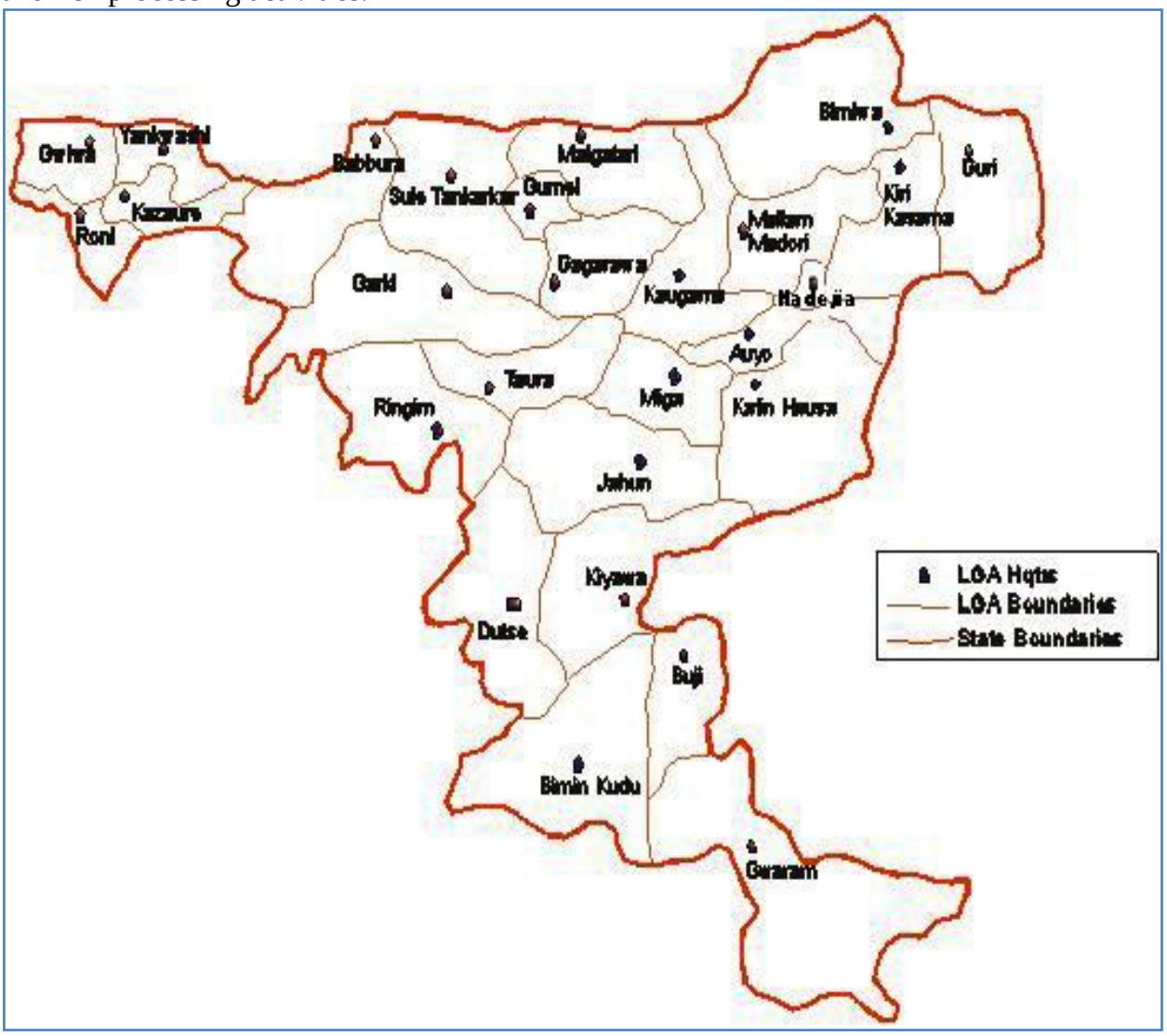


Figure 3.1: Map of Jigawa State, the study area.

3.2 Sampling Procedure and Sample Size

Purposive sampling was used to sample four villages where improved Rice processing technologies have been introduced for women. The study focused on the population of women involved in rice processing in the selected villages where the technologies were introduced between 1-5 years ago. These villages were: Kafin-Gana and Chiyeko in Birnin Kudu L.G.A, Hantsu in Miga L.G.A and Magarya in Auyo L.G.A. These were the villages that benefited from the JARDA rice processing technologies dissemination.

According to JARDA (2006) report, in each village, there were 30 women rice processors that have been trained on the improved rice processing technology and

were assisted with the equipment. All the 30 respondents from each of the selected 4 villages served as respondents making 120 respondents all together. Similarly, another set of 120 women in these villages that were not trained were randomly selected and served as counter respondents to see whether the technologies were diffused and adopted among the trained and untrained women rice processors in the study areas.

3.3 Method of Data Collection

Primary data were collected using a questionnaire on the women's socio-economic characteristics such as age, educational level, household size, processing experience, membership of social group, amount of credit received, and contact with extension agent. The questionnaires were administered by enumerators trained for the purpose under the supervision of the researcher between 26th May, 2013 and 5th June, 2013.

3.4 Analytical Techniques

Data collected were subjected to simple descriptive statistics namely average, Percentages and frequency distributions to describe the socio-economic characteristics of the women rice processors in the study area, ascertain the level of awareness of improved rice processing technologies by women rice processors in the study areas and determine the constraints to the adoption of rice processing technologies by women in the study areas. To find the level of adoption of the technologies, the following equation was applied.

$$\text{Level of adoption} = \frac{\text{Number of Technologies adopted}}{\text{Total number of technologies}} \times 100$$

In this study, total numbers of technologies are seven. Multiple regression model was employed to determine the contribution of the socio-economic factors to adoption improved rice processing technologies by women rice processors in the study areas. Similarly, multiple regression was used because the variables were

measured with interval scale exceeding 1 and 2. The expressions of the equation in explicit and implicit forms are as follows:

$Y = f(x_1, x_2, x_3 \text{ ---------- } x_7, U)$ (explicit form)

$Y = a+b_1x_1+b_2x_2+b_3x_3+b_4x_4+b_5x_5+b_6x_6+b_7x_7+e$ (implicit form)

Where:

Y = Adoption of improved rice processing technologies

x_1 = Age (years)

x_2 = literacy level (years)

x_3 = Household size (Number of persons in the household)

x_4 = Processing experience (Years)

x_5 = Membership of social groups (number of groups one belonged)

x_6 = credit received (dummy;1= accessible;0=inaccessible)

x_7 = Contact with extension agent (Number of visits in 2012)

a = constant term

U = error term (explicit)

e = Error term (implicit)

b_1 to b_7 = Regression coefficient of x_1 to x_7

x_1 to x_7 = Independent variables as defined in the general and explicit equations above.

3.5 Measurement of Variables

3.5.1 Independent variables

i. **Age**: This was measured by the actual age of the respondent given at the time of the study.

ii. **literacy level**: Education is a variable which tends to increase ones access and opportunities to diverse knowledge. This was scored and measured as the years spent in formal education.

iii. **Household size:** Was measured by the actual number of children, husband and other dependants of the respondents living in the women processors house at the time of the study.

iv. **Processing experience:** This was measured as years of involvement in the rice processing activity.

v. **Membership of social groups**: This was measured by the number of groups the women processors belonged. Each group will be scored as one point and the total number will be counted to form the score.

vi. **Credit received**: This refer to the external sources of fund received by women rice processors from any donor agency or government for processing activities. For those that have received credit = 1 and for those that do not have = 0.

vii. **Extension Visits**: it was measured by the total number of times the women processors received visits or information from the extension worker.

3.5.2 Dependent variable.

Adoption was the dependent variable: The level of adoption for each respondent was measured as the total number of the technologies adopted by the individual out of the 7 technologies that were introduced to them. These are: 200kg capacity rice parboiler and containers, local destoning sieves, stitching machine, weighing scales, packaging materials, rice mill and drying slab.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Socio-Economic Characteristics of the Respondents.

4.1.1 Age of respondents

The socio-economic characteristics of the respondents were examined with respect to their age, household size, educational level, credit received, extension visits, membership of social group and processing experience as presented in Table 1. The study revealed that the average age of the respondents was 34 years. However, 53.3% of the trained and 26.7% of the untrained respondents belong to the age range of 40 – 49 years, 1.7% and 29.2% of the trained and untrained respondents respectively belong to the age range of 20 – 29 years. While 26.7% and 35.8% of the trained and untrained respondents belong to the age range of 30 – 39 years. Similarly, only 18.3% and 8.3% of the trained and untrained respondents belong to the age range of 50-59 years. These ages range could be regarded as the economic active age group in which most processors put on their best in the processing business, this clearly shows that the processors are in the middle age class. This agrees with Olaniyan (1998) who found in his study adoption of improved cassava processing technologies that majority of the women processors were in their active age of 21-40 years. Similarly, Amaza (2007) found that most of the Nigerian

farmers were between 30-50 years of age. The minimum and maximum ages of the respondents were 20 and 55 years respectively.

4.1.2 Household size

Findings from the study shows that the average household size was 6 members per household, and most household (61.6%) have between 6-10 family members 32.5% and 28.3% of the trained and untrained households have between 1-5 members. While 10.8% and 15.8% have between 11-15 members, similarly, 3.3% and 9.2% have between 16-20 members per household respectively. The minimum and maximum family sizes of the respondents were 2 and 18 respectively. Household composition is a very important consideration in determining the labour available for rice processing operations. Most of the respondents were between 6-10 members implying that they have enough labour to perform their parboiling operations which is the most labour requiring operation in rice processing.

4.1.3 Literacy level

The result in Table 4.1 shows that majority of the women processors (80 and 70% of the trained and untrained groups) have no formal education, 17.5% and 25.8% acquired primary education while 2.5% and 4.2% of the trained and untrained respondents have secondary education respectively. The level of awareness and adoption of agricultural innovation are affected by the literacy status of farmers (Tiwari, 2010). Those who are literate are expected to be more innovative because

of their ability to access information more quickly and ability to be more likely adventurous. This is because rice processing technologies requires the use of machines and weighing scales that need accurate setting.

This finding is in consonance with that of Apata et al. (2010) and Tiwari (2010) who found that most of the Nigerian farmers have no formal education and this contribute to less adoption of technologies disseminated to them. Since farmers with high education had better recognition of advantages of new technologies.

4.1.4 Processing experience

The sampled processors had rice processing experience ranging from 3 to 30 years Table 4.1. However, majority of the processors had processing experience of 11-20 years (45.8% and 54.2% of the trained and untrained rice processors respectively) which shows that the processors were quite experienced and should be able to know which type of processing technology are good for adoption. The result further disclosed that, 42.5% and 40.8% of the trained and untrained respondents have between 1-10 years processing experience respectively. While 11.7% and 5.0% of the trained and untrained respondents have between 21-30 years experience in rice processing business. This implies that, older processors with higher experience are more likely to adopt a new technology with higher relative advantage over their traditional practice. In this study, it is expected that the experienced processors would not stick to their traditional practices or resist change, because they have mastered their jobs and they should be able to process better using the improved method.

4.1.5 Extension contact

The distribution of the respondents according to their extension visits is represented in Table 4.1. The study revealed that majority (70.8% trained and 100% untrained respondents) has never had any extension contact in 2012. While 26.7% and 2.5% of the trained respondents had 1-2 visits in 2012. This implies that the performance of the extension agents is low. This study agreed with Ayoade & Akintunde (2012) who also found that inadequate extension visits limits women participation and adoption of agricultural program. Similarly, Swanson *et al.* (1984) found that women had little or no contacts with extension services

4.1.6 Membership of social group

The result in Table 4.1 shows the distribution of the respondents by their membership of social groups. The result shows that 57.5% trained and 100% of the untrained respondents did not belong to any social group. While 41.7% and 0.8% of the trained respondents belonged to one and two social groups respectively. This implies that since majority of the women processors did not belong to any social group, there is a tendency that they would not benefit much from government intervention policies and programs which are shifted towards commodity associations since currently, the jigawa state government focuses only associations or groups for assistant and involvement in designed programmes. The implication of this scenario would adversely affect the adoption of the rice processing technologies introduced.

4.1.7 Credit received

The distribution of the respondents according to credit received in 2012 is shown in Table 4.1. The result shows that only 16.7% trained and 5% untrained respondents received credit. 80.8% trained and 86.7% untrained respondents did not receive credit in 2012. While the remaining 2.5% trained and 8.3% untrained respondents did not respond to this question probably because of reasons best known to them. Ekong (2003), stated that credit is a very strong factor that is needed to acquire or develop an enterprise. Its availability could determine the extent of production capacity. This lack of credit negatively affects the adoption of the improved rice processing technologies in the study areas, because even though they want to practice the technologies learned, they are still faced with financial constraints to acquire the improved equipment required to give the best results, also, they require capital to purchase raw materials (such as rice paddy) to make maximum utilizations of the equipment.

Table 4.1: Socio Economic characteristics of the respondents

	Trained			Untrained		
Variable	**Frequency**	**%**	**Mean**	**Frequency**	**%**	**Mean**
Age (years)						
20 – 29	2	1.7		35	29.2	
30 – 39	32	26.7	34	43	35.8	34
40 – 49	64	53.3		32	26.7	
50 – 59	22	18.3		10	8.3	
Total	120	100		120	100	
Household size						
1 -5	39	32.5		34	28.3	
6 – 10	64	53.3	6	56	46.7	6
11 – 15	13	10.8		19	15.8	
16 – 20	4	3.3		11	9.2	
Total	120	100		120	100	
Educational level						
No formal education	96	80		84	70	
Primary education	21	17.5	-	31	25.8	-
Secondary education	3	2.5		5	4.2	
Total	120	100		120	100	
Processing Experience in rice business						
1 – 10	51	42.5		49	40.8	
11 – 20	55	45.8	11	65	54.2	11
21 – 30	14	11.7		6	5.0	
Total	120	100		120	100	
Extension Contact						
0	86	70.8		120	100	
1	32	26.7	-	-	-	-
2	3	2.5		-	-	-
3	-	-	-	-	-	-
Total	120	100		120	100	
Membership of Social Group						
0	69	57.5		120	100	
1	50	41.7	1	-	-	1
2	1	0.8		-	-	-
Total	120	100		120	100	
Access to Credit						
No response	3	2.5		10	8.3	
Yes	20	16.7	-	6	5.0	-
No	97	80.8		104	86.7	
Total	120	100		120	100	

4.2 Level of Awareness of Improved Rice Processing Technologies by the Untrained Women Processors in the Study Areas.

Table 4.2 represents the distribution of respondents according to their level of awareness of the seven different rice processing technologies considered for the study. The technologies are improved rice parboiler, local destoning sieves, stitching machine, weighing scale, packaging materials, rice mill and drying slab. The trained groups were all aware of these technologies. While out of the 120 respondents who were not trained, 50% were aware of the improve rice parboiler, 4.17% were aware of local destoning sieves, 8.33 were aware of stitching machine and 20.83% were aware of weighing scale. Similarly, 41.67% were aware of packaging material, 100% of the respondents were all aware of the rice mill and 66.67% were aware of drying slab. The percentages presented are as a result of multiple responses from the processors. The study revealed that an average of 41.67% of the respondents were aware of most of the technologies. Rogers (2003), states that the adoption process takes place at the individual level and is the mental process that starts when an individual first hears about an innovation and ends to its final adoption or rejection. He goes further to distinguish five phases in the technology adoption process of which awareness is the first phase. The study revealed that less than 50% of the respondents were not aware of all the technologies, this implies that since majority of the respondents were not aware of the technologies, the adoption rate would be low. And for the technologies to be diffused and adopted, more awareness creation should be carried out.

Table 4.2: Distribution of the respondents according to their level of awareness of improved rice processing technologies (n=120)

Improved rice processing technologies	Level of awareness untrained respondents	
	No. of Respondents	Percentage
Improve rice parboiler	60	50.00
Local destoning sieves	05	04.17
Stitching machine	10	08.33
Weighing scales	25	20.83
Packaging materials	50	41.67
Rice mill	120	100.00
Drying slab	80	66,67

* multiple response allowed

4.3 Level of Adoption of the Improve Rice Processing Technologies by both Trained and Untrained Women Rice Processors in the Study Areas

Adoption in this study was considered based on continuous use of technologies by the respondents and also the number of technologies that were used out of the seven technologies under study. Table 4.3 presents the level of adoption for the trained and untrained groups. The level of adoption of the trained group is higher than that of the untrained group probably because of the high awareness of the trained group. The level of adoption of the trained group for the various technologies were 51.67% for improved parboiler, 14.17% for local destoning sieves, 0.83% for stitching machine, 3.33% for packaging materials, 16.67% for drying slab, while 100% of the respondents do not adopt the use of the weighing scale. Rice mill was adopted by all the respondents because of the drudgery associated with local milling using pestle and mortar and the reduction of sand contents in the rice, because fine sand is

place inside the parboiled rice and mix to aid in abrasion to remove the husk from the grain. They added that weighing scale waste time in reading and trying to adjust measurement by adding or subtracting the quantity to get accurate measure, but mudu is straight forward and faster.

The stitching machine and packaging materials were not also adopted because the respondents are trying to run away from addition of extra cost in production which would not add to the existing market price in the locality because the local customers are not willing to pay for extra money over the existing price. The concrete drying slab was not adopted because they prefer to use tarpaulin which they can remove and keep after drying the commodity and they can spread it anywhere they like, unlike the slab which is permanently placed in one location and cannot be removed. The implication of these is that, in the process of packing and spreading of the rice, it get contaminated with a lot of sand and impurities which lower the commercial value of the product.

The general low adoption rate of the technologies for the untrained group is attributed to the low awareness creation and training of the respondents, although the respondents adopted rice mill (100%) because it was their pressing need and they were already aware about the equipment since before the introduction of it to the trained group. Apart from the rice mill only improved parboiler and drying slab were adopted by 4.17% and 6.67% of the respondents respectively.

Table 4.3: Distribution of the respondents according to their level of adoption of improved rice processing technologies (n=120)

	Improved rice processing Technologies	Trained & adopted		Untrained and adopted	
		Respondents	Percentage	Respondents	Percentage
1	Improve rice parboiler	62	51.67	5	4.17
2	Local destoning sieves	17	14.17	0	0.00
3	Stitching machine	1	00.83	0	0.00
4	Weighing scales	0	00.00	0	0.00
5	Packaging materials	4	03.33	0	0.00
6	Rice mill	120	100.00	120	120
7	Drying slab	20	16.67	8	6.67

* multiple response allowed

4.4 Socio-economic Factors that Influence the Adoption of the Improved Rice Processing Technologies by Women in the Study Areas

The fourth objective of the study was to determine the socio-economic factors influencing the adoption of the improve rice processing technologies by women in the study areas. Multiple regression analysis was used in order to determine the specific contribution of each independent variable and the total variance explained by all the variables on factors influencing the adoption of the improve rice processing technologies (Table 4.4). The result shows that the adjusted R^2 had a value of 0.601 indicating that 60.1% variation in adoption of technologies was explained by the characteristics. The study reveals the following:

Age: Age was found to be significantly related to the adoption of improved rice processing technologies, but has a negative influence among the respondents. The regression coefficient (-0.102) showed that age is significant at 10% level of

significance. The negative influence of age could be expected as a result of the fact that as farmers grow old, there is the tendency to reduce level of adoption as their ability to cope with various farm operations diminishes (Mustapha *et al.* 2010). Similarly, age is significant because of the drudgery involved in rice processing operations. The older women have less energy to carry out the operations very well. This is in line with a study carried out by Eneh (2008) on factors affecting adoption of improved palm oil processing technologies by women in Igboeze North L.G.A. of Enugu State.

Educational level: The regression analysis of the study indicated that formal education (0.125) was not significantly related to the adoption of improved rice processing technologies by women in the study area. The general low level of education of the respondents in the study area could be responsible for lack of correlation between education and adoption. The study is in line with that carried out by Oladimeji (2001) on adoption of improved technologies for cotton production by farmers in Katsina State and that of Nchinda and Mendi (2008) on factors influencing the adoption of yoghurt technology in the Western Highlands Agro-ecological zones of Cameroon. Similarly, Suleiman (2012) in his study found that education level and extension contact did not have significant influence on the adoption of improved cassava processing technologies by women in Akoko Edo L.G.A. of Edo State.

Household size: From the analysis, the regression coefficient of household (-0.072) is not significantly related to adoption of improved rice processing technologies in the study area. The possible explanation of this is that most household have more than 6 members and this is a characteristics of most households in the study area

which means they have enough family labour. This results fully agrees with that of Tijjani (2010) who also found household size to be insignificant in the adoption of recommended cowpea production practices.

Processing experience: The regression analysis shows that processing experience (0.069) have significant relationship in the adoption of improved rice processing technologies at 5% level of significance. This implies that, the higher the processing experience, the higher the adoption of processing technologies. This agrees with a finding by Adejoh (2006), who also found that processing experience have a significant influence on the adoption of improved cassava processing technologies by women.

Membership of a Social Group: From the result of the study, membership of a social group (0.248) have a significant relationship with adoption of improved rice processing technologies at 5% level of significance. This is because members in an association can easily be induce to adopt technologies easily than non-group members due to influence from colleagues and also groups are the focal points for all government and non-governmental organization interventions. Therefore, there is a quick awareness and motivation of new technologies in a group.

Credit received: The regression analysis showed that access to credit (0.094) is significant as a factor influencing the adoption of improved rice processing technologies at 10% level of significance. This is possibly because as farmers receive more credit, the more likely the farmers would adopt the improved technologies introduced to them. Similarly, if a recommendation implies a significant cash investment for farmers or processors, an efficient credit programme may facilitate adoption. This study is in line with that carried out by Mamman

(2012) on factors influencing adoption of improved dairy cattle technologies in peri-urban areas of Northern Nigeria.

Extension contact: The regression analysis result (0.026) shows that extension contact have no significant relationship in the adoption of the improved rice processing technologies. Report from the field indicated poor extension contact, but several research, reported that, regular and effective extension contact will increase the awareness and adoption levels of the improved rice processing technologies. This agrees with the findings of Atala (1984) who confirmed the important role of extension agent in the diffusion and adoption of innovation. This finding is in line with that of Olaniyan (1998) who found extension contact not significantly related to adoption of improved cassava processing technologies.

From the analysis, it was found that Age (-0.102), processing experience (0.069), membership of Association (0.248) and Access to credit (0.094) were significantly related to adoption of the improved rice processing technologies by women. The other variables; Education level, household size and extension contact did not have significant influence on adoption of improve rice processing technologies. The null hypothesis which stated that, "There is no significant relationship between the socio-economic characteristics of women rice processors and adoption of improved rice processing technologies is therefore rejected". The result obtained from this study showed that out of the 7 socio economic variables (age, education level, household size, processing experience, membership of association, access to credit and extension contact), four were significantly related to the adoption of improved rice processing technologies.

Table 4.4: Multiple Regression result of socio-economic factors influencing the adoption of improved rice processing technologies by respondents

Variables	**Regression coefficient**	**Standard error**	**T-value**
Age (X_1)	-0.102**	0.063	-0.0199
Educational level (X_2)	0.125^{NS}	0.265	0.1026
Household size (X_3)	-0.072^{NS}	0.279	-0.0622
Processing experience (X_4)	0.069**	0.035	0.0075
Membership of association (X_5)	0.248*	0.038	0.0292
Access to credit (X_6)	0.094**	0.049	0.0143
Extension contact (X_7)	0.026^{NS}	0.004	0.0003

$R^2 = 0.650$ $R^{-2} = 0.601$ $F = 3.098$

*P<0.10; **P>0.01

NS= Not significant

$Y = f(X_1, X_2, X_3$ ---------- X_7 U)

Age = 3.098(-0.102 x 0.063) = -0.0199
Education level = 3.098(0.125 x 0.265) = 0.1026
Household size = 3.098(-0.072 x 0.279) = -0.0622
Processing experience = 3.098(0.069 x 0.035) = 0.0075
Membership of association = 3.098(0.248 x 0.038) = 0.0292
Access to credit = 3.098(0.094 x 0.049) = 0.00143
Extension contact = 3.098(0.026 x 0.004) = 0.0003

4.5 Constraints to the Adoption of Improved Rice Processing Technologies by Women in the Study Areas

Table 4.5 reveals the constraints encountered by women in adoption of the improved rice processing technologies. The results indicated that 99.2% of the trained group and 96.67% of the untrained group agreed that there was no working capital. The implication could be that the respondents were unable to purchase the required input as a result of high prices associated with the commodity. Lack of good market for the product is another constraints stressed by 97.5% of the trained and 95.83% of the

untrained respondents. This implies that the production of the commodity would be affected negatively and could lead to low adoption of technologies. Another constraints is that equipment are not enough to cater for the needs of all the respondents as mentioned by 97.5% and 95% of the trained and untrained groups respectively. This means that a long time would be taken for the technology to be diffused since it is not enough to cover a reasonable area within the short time. Lack of difference in the selling price of the commodity between the improved processed and locally processed products is another constraint faced by the women as mentioned by 66.7% of the trained group and 50.83% of the untrained group, this discourages the processors to spend time and produce high quality products without any incentive at the end.

Lack of awareness of the technology is another constraint as mentioned by 32.50% of the untrained group, which means that some of the respondents from the untrained group might have adopted the technologies had it been they were aware about the technologies. This was explained by the adoption theory which pointed out awareness as the first step in the adoption decision process.

Poor extension contact as was mentioned by 25% and 33.33% of the trained and untrained group respectively. Poor extension services confirm the report by Tiwari (2010), that one of the major constraints of farmers was poor access to extension services. For this reason the adoption level of the respondents could be affected negatively. However, the study indicated that majority of the respondents did not

agree that sabotage by men is a constraints that prevent the women from adopting the improved rice processing technologies.

Table 4.5: Constraints to the adoption of improved rice processing technologies by women in the study areas (n=120)

	Trained group		Untrained group	
Constraints	**Frequency**	**Percentage**	**Frequency**	**Percentage**
No working capital	119	99.20	116	96.67
No good market	117	97.50	115	95.83
Equipment are not enough	117	97.50	114	95.00
No difference in selling price with conventional methods	80	66.67	61	50.83
Lack of awareness of the equipment	0	0.00	39	32.59
No training received on improved rice processing technologies	0	0.00	17	14.17
No good leadership in the group	10	8.33	1	0.80
Poor extension contact	30	25.00	40	33.33
No frequent monitoring of group	1	0.80	0	0.00
Sabotage by men	1	0.80	0	0.00

* multiple responses exist hence % >100

4.6 Influence of the Technologies on the Income of the Rice Processors in the Study Areas.

Average price of rice paddy one bag of 85kg in 20112 = ₦6,500

Average price of milled rice 50kg bag in 2012 = N8,100

Table 4.6: Profit made by the respondents in 2012

	Trained		Untrained	
Variable	**Frequency**	**Percentage**	**Frequency**	**Percentage**
1,000 – 10,000	2	1.7	26	21.7
11,000 – 20,000	15	12.5	48	40.0
21,000 – 30,000	26	21.7	20	16.7
31,000 – 40,000	40	33.3	16	13.3
41,000 – above	37	30.8	10	8.3
Total	**120**	**100**	**120**	**100**

Having applied the technologies to produce quality milled rice, the trained respondents make more sales and process rice paddy more often due to patronage from their customers. The Table above shows how the influence of the technologies affects their income level. 85.8% of the trained respondents were able to make a profit of above ₦21,000 in 2012 through the sales of the improved processed milled rice. Whereas only 38.3% of the untrained respondents were able to make a profit of above ₦21,000.00 which clearly shows the influence of the technologies on the income level of the respondents.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The broad objective of the study is to assess the socio-economic factors influencing the adoption of improved rice processing technologies by women rice processors in four villages namely; Kafin-Gana and Chiyeko in Birnin Kudu L.G.A., Hantsu in Miga L.G.A. and Magarya in Auyo L.G.A. of Jigawa State. 240 respondents were used in the study, majority of the respondents are between the ages of 30-39 years, 56.5% have been in the processing business between 11-20 years, 70% have no formal education and 90% of them do not have contact with extension agents. Similarly, 78.8% do not belong to any social group and 83.8% do not have access to credit.

The study revealed that 41.6% of the untrained groups were aware of all the technologies. The adoption rate of the technologies was generally low with the exception of rice mill which was adopted by 100% of the respondents.

The study revealed that Age (-0.102), processing experience (0.069), membership of association (0.248) and Access to credit (0.094) have a significant relationship with adoption of improved rice processing technologies by women in the study areas. While Education level (0.125), household size (-0.072) and Extension contact (0.026) were not significantly related to the adoption of improved rice processing technologies in the study areas.

The study further showed that, the major constraints to the adoption of the technologies were lack of working capital, lack of good market and lack of enough equipment as mentioned by over 90% of the respondents. Other important constraints are lack of difference in selling price of the commodity between improved processed and locally processed as mentioned by 66.67% of the trained groups and 50.83% of the untrained group and poor extension contact as mentioned by 25% and 33.33% of the trained and untrained groups respectively.

5.2 Conclusion

Findings from the research indicated four factors that significantly influenced the adoption of improved rice processing technologies in the study area, these are; Age, processing experience, membership of association and Access to credit. Most households have enough labour (6-10 members) which contributed in the low adoption rate of the technologies .Majority of the processors did not receive credit in 2012. This contributed to their low purchasing power to purchase the equipment and adopt the improved rice processing technologies.

Consequently, despite high level of awareness (67%) among both the total groups, only 30.4% adoption rate of the whole equipment was recorded. The study further revealed poor extension contact, inadequate credit facilities and availability of improved equipment, lack of selling price difference between improved processed and locally processed rice as the major constraints hindering the adoption of the technologies.

5.3 Contributions to Knowledge

i. The study revealed that the level of adoption of the whole equipment was 30% which was caused mainly by lack of selling price difference between the improved processed milled rice and locally processed milled rice as an incentive attached to the technologies.

ii. The women rice processors do not have good bargaining power against the middlemen because 79% of the women do not belong to any social group this is the main reason why the middlemen do not want to increase purchase price even though the quality of the improved processed milled rice was better.

iii. The study also found that 70% of the women rice processors in the study area do not have formal education which will affect their ability to access information more quickly.

5.4 Recommendations

Based on the findings of the study, the following are recommended:

- There are limited extension services in the study area which is linked to inadequate number of extension staff, government should recruit more extension agents to cover more areas to effectively disseminate improved rice processing technologies to the rural areas similarly private extension services should be encouraged to complement government effort in educating women processors.
- Most of the processors do not have formal education therefore; adult education should be encouraged and promoted to educate rural women rice processors so that at least they can read and write.

- 78.8% of the processors in the study areas do not belong to any social group such as women rice processors association, it is therefore recommended that processors should organize themselves into cooperatives so that they can benefit from policies and programmes designed by the government and other Non governmental agencies and which only group members benefit.
- It was discovered that majority of the processors did not receive credit in 2012, therefore, processors should be linked to financial institutions to source loans to boost their business.
- The level of awareness for the untrained group is very low, as such, more awareness creation of the improved processing technologies is recommended in the study areas through step down training to be conducted by the trained group.
- The level of adoption of the whole equipment is generally low because there is no incentive attached to the price of the improved processed rice. Similarly, processors were not selling their products in group. Therefore, processors should organize themselves into groups so that, they can have good bargaining power against the middlemen since they are producing better quality stone free rice.

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APPENDIX: QUESTIONNAIRE FOR WOMEN RICE PROCESSORS IN JIGAWA STATE

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY, AHMADU BELLO UNIVERSITY, ZARIA

Dear Sir/Madam,

I am a post graduate student of Ahmadu Bello University, Zaria, currently working on the topic: "Socio – economic factors influencing the adoption of improved Rice processing technologies by women in Jigawa Sate, Nigeria".

Kindly answer the following research questions in respect to this work. Your responses will be treated with high confidentiality. Your cooperation will be most gratefully appreciated.

Thank you.

ADO NASIRU

SECTION A: BACKGROUND INFORMATION

1. Name of Respondent: ……...
2. Name of Village: ……..
3. Name of L.G.A: ……..

SECTION B: Socio – economic Characteristics of the farmer.

4. Age: ……. Years
5. Sex: Male ( ) Female ( )
6. Marital Status: Married ( ) Single ( )
7. Indicate your Household Size including other people living with you:
   ( )
8. Educational Level: how many years have you spent in formal education
   ( )
9. How long have you been in rice processing? …….. Years
10. Have you had any visit by extension agents in 2012? Yes ( ) No( )
11. If yes, how many times were you visited by the extension agents with information on improved rice processing technologies in 2012? ……. Times.
12. Are you satisfied with the visits? Yes ( )No ( )

13. If yes, give reasons: ……..

…….

14. If no, give reasons: ……

15. Do you have access to credit? Yes ( ) No ( )

16. If no, how do you finance your rice processing business?

……

……

17. If yes, state sources and amount of credit received in 2012.

S/NO	SOURCE	AMOUNT (₦)

18. Did you return the credit after the agreed period?

Yes ( ) No ( )

19. If no, please give reasons for not returning the credit,

……

……

.. 20. Do you belong to any social group? Yes ( )No. ( )

21. If yes, how many groups: ……?

SECTION C: Level of awareness of the improved rice processing technology.

22. Which of the following rice processing technologies are you aware of:

a- Improved rice parboiler ( )

b- Local destroying sieves ( )

c- Stitching Machine ( )

d- Weighing Scale ( )

e- Packaging Materials ( )

f- Rice Mill ( )

g- Drying Slab ( )

SECTION D: Level of adoption of the improved rice processing technologies

23. Which of these improved technologies have you adopted on large scale and on a continuous basis?

a- Improved rice parboiler ( )

b- Local destroying sieves ( )

c- Stitching Machine ( )

d- Weighing Scale ( )

e- Packaging Materials ( )

f- Rice Mill ( )

g- Drying Slab ( )

24. State reasons for using the technologies chosen above:

a- Simple to use ( )

b- Process large quantity at a time ( )

c- Faster processing operations ( )

d- Process quality products without stones ( )

e- Any other reason(s)……

25. State reasons for not using the technologies chosen above:

a- Equipment are not enough ( )

b- Labour intensive ( )

c- No difference in quality with conventional method ( )

d- Equipment are expensive to buy ( )

e- No difference in selling price with conventional method ( )

f- Any other reason(s)……

SECTION E: Processing Capacity by the processor

26. How many bags of paddy did you processed in 2012?: …….. Bags

27. Did you have available labour for rice processing operations in 2012

Yes ( ) No ( )

28. If yes how many people: **……..**

29. Did you use family labour for your rice processing in 2012?

    Yes ( ) No ( )

30. If yes, how many from your family did you use: …… in 2012?
31. Did you use hired labour for you rice processing operations in 2012?

    Yes ( ) No ( )

32. How much did you pay per 5hrs (Man – day) in 2012? : ……
33. What was the price in Naira of rice paddy in 2012? : ……
34. What was the price of one bag 50kg bag of parboiled rice you sold in 2012? : ……...

35. Did you make profit in 2012? Yes ( ) No ( )
36. If yes, how much in Naira: ……
37. Did you buy anything with the profit you get from rice processing in 2012?

    Yes ( ) No ( )

38. If yes, list items and costs:

    i. ……

    ii. ……

    iii. ……

39. Is there any difference in quality as a result of adoption of the improved rice processing technologies? Yes ( ) No ( )
40. If yes, how? Decrease ( ) Increase ( )
41. If increase, how did the increase affect your income? Please tick as applicable to you.
    a- Very High ( )
    b- High ( )
    c- Average ( )
    d- Low ( )
    e- Very Low ( )
42. How has the increase in income from the quality processed rice affected your standard of living?
    a- Very High ( )
    b- High ( )
    c- Average ( )
    d- Low ( )

e- Very Low ( )

SECTION G: constraints to the adoption of rice processing technologies by women.

43. What are the problems facing you in the adoption of the improved rice processing technologies in your area?:
    a- No working capital ( )
    b- No enough equipment ( )
    c- No good market ( )
    d- No good leadership in the group ( )
    e- No selling price difference with conventional method ( )
    f- Any other reason(s)…….
    ……
44. What suggestions with you give that will help to accelerate the process of using the improved rice processing technologies in your area?
    a- Link processors with good market ( )
    b- Link processors with financial institution to get loan ( )
    c-Link processors with fabricators to get equipment ( )
    d-There should be constant monitoring of group activities ( )
    e-Group leaders should be train on group dynamics ( )
    g- Any other suggestion(s)……
    ……
    ……

Thank you very much.