ANALYSIS OF THE IMPACT OF ADOPTION OF MODIFIED DRUM OVENTECHNOLOGY ON INCOME AND LEVEL OF LIVING OF FISH PROCESSORS IN NIGER 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 DOCTOR OF PHILOSOPY DEGREE IN AGRICULTURAL EXTENSION AND RURAL SOCIOLOGY

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MARCH, 2016

DECLARATION

I hereby declare that this thesis titled "**Analysis of the Impact of Adoption of Modified Drum Oven Technology on income and Level of Living of Fish Processors in Niger State, Nigeria**" was written by me and is a result of my research work. It has not been presented by any previous applicant for a higher degree anywhere else. All ideas borrowed in this work were duly acknowledged in the text and list of references provided.

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CERTIFICATION

This thesis titled **"Analysis of the Impact of Adoption of Modified Drum Oven Technology on income and Level of Living of Fish Processors in Niger State, Nigeria"** by AHMADU, Hajara Jabiru meets the regulations governing the award of degree of Doctor of Philosophy (PhD) in Agricultural Extension and Rural Sociology of Ahmadu Bello University Zaria and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This project is dedicated to the blessed memory of my Parents Engr A.J Ahmadu and Mrs. R.L. Ahmed,may their gentle souls rest in perfect peace “Ameen”

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LIST OF ACRONYMS

ADPs – Agricultural Development Programmes

CBN – Central Bank of Nigeria

FAO – Food and Agriculture Organization

FDS – Federal Department of Statistics

FISON- Fisheries Society of Nigeria

Kg – Kilogram

Km^2 – Kilometers square

M^2 - Meter Square

Mt- Metric tonnes

MOARD - Ministry of Agriculture and Rural Development

NAERLS – National Agricultural Extension and Research Liaison Services

NAMDA – Niger State Agricultural and Mechanization Development Authority

NARIs – National Agricultural Research Institutes

NGOs – Non-Governmental Organizations

NIFFR – National Institute of Fresh Water Fisheries Research

NIOMR- Nigeria Institute for Oceanography and Marine Research

UNDP – United Nations Development Programme

VEA – Village Extension Agent

ABSTRACT

This study was carried out to analyze the impact of adoption of modified drum oven technology on income and Level of Living of Fish Processors in Niger State, Nigeria. Data for the study were collected using questionnaire administered to 320 fish processors in eight (8) LGAs of Niger State. The LGAs were purposively selected because of the intensity of fishing and fish processing activities. The selection was done using a multi stage sampling technique and the data were collected in 2015. Descriptive statistics and inferential statistics were used to analyze the data. The study revealed that majority (52%) of the fish processors were male indicating that more men were involved in the processing of fish. About 50% of the fish processors fell between 40 -49 years of age with a mean age of 34 years which indicates that younger people are into modified drum oven fish processing in the study area. Majority (79%) of the fish processors had one form of formal education or the other ranging from Quranic, adult, primary, secondary and tertiary education. Most (78%) of the respondents had between 1 – 3 family members involved in modified drum oven fish processing. Over 56% of the fish processors are members of cooperative organizations. Most (66%) of the fish processors had no access to credit. Most (89%) of the respondents processed an average of 1 – 50 kilograms of fish daily. The result of the Z test showed that the calculated Z value (2665.17) is greater than the table Z value of 1.64 at one tail and 1.96 at two tails respectively and it is significant at 1% probability level. The logit regression model result revealed that with the exception of marital status, level of education, household size, extension contact, membership of cooperative, access to credit and affordability which were not significant, the estimated coefficients for parameters like, age (0.047), experience in fish processing (0.048) and compatibility (0.412) which are significant at 5% probability level, sex (3.448), income (2.256) and processed fish output (2.385) were significant at 1% probability level implying that these factors have significant influence on adoption of modified drum oven fish processing technology. The foremost constraint inhibiting the adoption of improved fish processing technology was inadequate capital. The study revealed that adoption of modified drum oven fish processing technology has an impact on fish processors income and level of living in the study area. Therefore the study recommends that proper sensitization of fish processors by NGOs and other development agencies on group formation and development and also on how the groups can be functional and viable. Research institute should design improved fish processing technologies that are accessible, user friendly and affordable to the fish processors

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Fish supplies about 50 per cent of animal protein globally in the diet of over 400 million poor people in Africa (CIGAR, 2012). It also complements the high carbohydrate diets in many regions (Madeley, 2007). The purpose of culturing fish is to have enough to eat and generate additional income for the fish farmer. Fish is an excellent source of mineral (calcium, phosphorus and iron), vitamins (A, B_1, B_2 and D) and important trace elements (Acheampong, 1996). Fish is also used in medical preparation (Fish oils), recreation (sport fishing or fishing festivals) and in other agricultural industries (fish meals, ornamentals and decorations).

Nigeria presently meets only 60 per cent of her total fish need and spends scarce foreign exchange in importing frozen and canned fish to supplement the deficit (Bolorunduro *et al*., 2005). Nigeria has a rich biodiversity that can bridge the gap between demand and supply, and also has the capacity to attain the desired fish self-sufficiency within a short time if the numerous fisheries potentials in the nation are adequately utilized. These potentials are estimated at about 2.5 million metric tons of fish annually (FMARD, 2011).The Fisheries sub sector over the years has been the highest generator of revenue in the Federal Ministry of Agriculture, for example farmed catfish market surpasses US$27 million per year with the highest production coming from South West of Nigeria and Nigeria is presently the highest producer of catfish in the whole of Africa (FMARD, 2011). There is the need for a strategic approach in development of the fisheries sub-sector in agriculture if the reported potential is to be realized. The fisheries and fish

resources of Nigeria are not only of considerable economic importance, but they are also making significant contributions to the national food security as well as providing major sources of employment in rural areas**.** Fishing and related activities are important sources of livelihood of majority of inhabitants in the rural area especially those close to the river areas. These activities are providing employment for a vast majority of the populace, as unskilled labourers easily adapt the processes involved.

Fish processing is the processes associated with fish and fish products between the time in which fish are caught or harvested and the time in which the final product is delivered to the customer (George *et al.*, 2014). The processing and preservation of fish were of utmost importance since fish is highly susceptible to deterioration immediately after harvest and to prevent economic losses (Okonta and Ekelemu, 2005). Efficient preparation of fish is important when top quality, maximum yield and highest possible profits are to be achieved (Davies and Davies, 2009). Inadequate fish handling, processing techniques and storage facilities contribute significantly to the low supply of fish to poor rural dwellers that form three quarters of the population in developing countries (Ayuba and Omeji, 2006). Akinneye *et al.* (2007) and Davies (2005) reported that the development of appropriate fishing machinery and techniques that employed effective production, handling, harvesting, processing and storage, cannot be over-emphasized especially in the age when aquaculture development is fast gathering momentum in Nigeria. Al Jufaili and Opara (2006) reported high incidence of fish losses as a major impediment to the realization of government goal towards increasing the contribution of the sector to the overall national economy. The use of appropriate technology which is a radical approach to stem up production and processing technique, has become subordinate to social need,

and is of paramount importance. Fish is a major source of protein and its harvesting, handling, processing and distribution provide livelihood for millions of people as well as providing foreign exchange earning to many countries (Al- Jufaili and Opara, 2006). Appropriate processing of fish enables maximal use of raw material and production of value-added products which is obviously the basis of fish processing profitability.

1.2 Problem Statement

Over 80% of fish produced in Nigeria is sold live (FMARD, 2012). One of the negative consequences of this is that the fish farmers at times are forced to sell at a not too profitable price, which may be a hindrance to expand their production. Fishery sub sector in particular has lately seen a surge in interest amongst the populace with fish diet becoming one of the most important foods of the nation. Fish production currently generates 91.92% and 13.82% in the artisanal and aquaculture sector (FDF, 2008). These have also lead to many people entering fishery activities because of the derived financial benefit and relatively ease in establishment. Due to poor handling about 30-50% of fish harvested are wasted in Nigeria (Olowoniyan *et al.,* 1998). Apart from the subsistence operation in catching fish, in most cases bacterial infection set in on the fish flesh as a result of injuries sustained in the traps and nets, open wound, and stress from struggling accelerating the deterioration of fish. There is the need to improve fish lifespan by more efficient fisheries management, development and improvement of the fish handling, processing, storage and distribution (Eyo, 1997). Most fish producing areas are far from the city centers where there are ready commercial markets and storage facilities. Even when they are near there is still the problem of fish spoilage due to high temperatures and humid climate. The rapid spoilage of fish products and lack of adequate storage facilities

are major reasons why there is the need to process these fish in other to add to the shelf life. Considerable attention is given to processing and value addition in fisheries sub sector in Nigeria in recent times.

It is widely acknowledged that fish processing and preservation can play a major role in improving productivity, reducing poverty and improving rural livelihood. With an estimated 10 million Nigerians actively engaged in the upstream and downstream areas of fisheries operations in Nigeria, the contribution of the fisheries sub-sector to the nation's economy is significant, ranging from employment creation to the provision of raw materials for the animal feed industry (Osagie, 2012). Most of the populace in these areas depends predominantly on fish for food and means of livelihood. The need to mechanize fish processing techniques has drawn the attention of National Agricultural Research Institutes to devote utmost interest and resources to engineering research in operation, to minimize the drudgery, ease labour operation, and unsanitary and inherent unhygienic handling that are mostly involved in the traditional manual operations (Davies and Davies, 2009). Over the years investments have been made in the area of improved fish processing technologies which has made processing a lot easier. The commonest methods and practices for traditional processing of fish products include smoke-drying, sun-drying and fermentation.The National Institute for fresh water and fish Research (NIFFR) in New Bussa Niger State developed a number of improved fish processing technologies like the gas smoking kiln (banda smoking kiln), the solar energy preservation (solar tent), modified drum oven, choker kiln, others are detachable fish smoking kiln 3-in- one smoking kiln (using electricity, gas and charcoal). Kiln or oven as it is referred to be a furnace for firing or burning of fish.

Successive governments in Nigeria over the years recognized the need to reduce the extent of losses to the barest minimum. Knowing the limitations of traditional processing equipments and the inadequacy of other methods used in processing, Research Institutes were funded to generate and package technologies to tackle these problems (Bolorunduro *et al.,* 2005).Traditional fish processing technology is associated with low capacity, poor processed fish and easy spoilage. The modified drum oven is a modification of the simple drum oven which is a traditional method of fish processing and the modified drum oven fish processing technology has advantages like fuel efficiency compared with the traditional technology, Produces good quality fish that command high price and is acceptable to consumers, less labour intensive and it is easy and cheaper to construct unlike other improved smoked kilns.Fish processing using this technology does not entail great capital expenditure and it is adopted by most small scale fish processors in Niger State. Smoked or dried fish can be viable and would have an advantage that it could be bought in quantity when money is available and stored for later consumption than when refrigerated fresh in a country where there is no steady power supply.

In spite of these efforts by Government and the research institutes, the production, processing and ancillary activities in the fisheries sector are still being carried out using the rudimentary methods. According to FAO reports (2010) the system is not operating in a sustainable and efficient manner. The adoption of improved fishery technologies is very low (Sule *et al.,* 2009) which has caused valuable losses to the fishery sector. Therefore an effort to provide empirical evidence on theimpact of adoption of modified drum ovenfish processing technologyon income and level of livingof fish processors in Niger State is an

imperativeresearch. Arising from the above, the study provided answers to the following questions:

i. What are the socio-economic characteristics of fish processors in the study area?
ii. What are the factors influencing adoption ofmodified drum oven fish processing technology?
iii. What are the fish processing activities in the study area?
iv. What is the impact of adoption of modified drum ovenfish processing technology on Fish processors income?
v. What is the impact of adoption ofmodified drum oven fish processing technology on fish processors level of living?
vi. What are the constraints inhibiting the adoption of the fish processing technologies in Niger State?

1.3 Objective of the Study

The broad objective of the study was to analyze factors influencing the adoption of modified drum ovenfish processing technology and its impact on income and level of living of fish processors in Niger State, Nigeria.The specific objectives of the study were to:

i. Describe the socio-economic characteristics of the fishprocessors in the study area;
ii. Determine the factors influencing adoption of modified drum oven fish processing technology;
iii. Identify the fish processing activities in the study area;
iv. Determine the impact of adoption of modified drum oven processing technology on fishprocessors income;

v. Determine the impact of adoption ofmodified drum oven fish processing technology on fish processors level of living and;

vi. Identify constraints inhibiting the adoption of fish processing technologies.

1.4 Hypotheses

The following hypotheses were tested:

i. Factors influencing adoption of modified drum ovenfish processing technology have no significant impact on fish processors income;

ii. Adoption of modified drum oven fish processing technology have no significant impact on fish processors income and;

iii. Adoption of modified drum oven fish processing technology has no significant impact on fish processors level of living.

1.5 Justification of the Study

Traditional fish processing technologies must be improved upon in Nigeria to reduce post- harvest losses and quality of fish and fishery products. The existing information on fish processing technologies in the country reflects low level of adoption of improved fish processing technologies in the country seeing that this is a serious problem in achieving food security in the country. There is no doubt that fish processing would play a unique role in promoting industrial development through employment generation, value-added processing and training of skilled manpower. The study looked at the modified drum oven fish processing technology. The modified drum oven was pioneered by NIFFR and NIOMR in the 1980s and was targeted at small-scale fish processors. It is an adaptation of

traditional mud kiln, the firing chamber, the smoking racks and the chimney all ensure efficient smoking of fish more than the traditional oven (Bolorunduro, 2004). Adoption of the modified drum oven has upgraded the traditional fish processing technologies and enhanced the supply of processed fish to the markets.

The study has greatly enhance our knowledge of the impact of adoption of modified drum oven fish processing technology on fish processors income and level of living and added to existing literature. The information from this research has added to relevant knowledge for policy formulation by government and research institutes that would create enabling environment for sustainable fish processing and also understanding of the activities involved in fish processing in Niger State and Nigeria at large. The study gave an insight into the fish processing technology relevant for use by interested fish processors and the significant constraints that inhibit the adoption of modified drum oven fish processing technology. Recommendations have been made so as to tackle some of the constraints faced by the fish processors on the adoption of modified drum oven technology.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Socio-economic Characteristics and Institutional Factors InfluencingAdoption of Agricultural Technologies

Scholars have identified socio-economic characteristics and institutional factors to influence adoption of technologies. Factors such as gender, age, education, family size, farming experience, membership of cooperative, marital status, household size, extension contact and income have been found to influence farmer's adoption of technologies. Kolawole*et al.* (2010), found age, education, extension contact and membership of association to be significantly related to adoption. Rahaman *et al.* (2002) found that farmers' age may influence adoption in several ways. Farmers younger in age are likely to accept innovations faster than those who are older and who are not ready to take risk (Okunlola, 2010). Njoku (1991) reported that formal education had a positive influence on adoption of innovations. Education influences adoption of technology, because the educated farmers have access to sources of information (journals, bulletins, and internet).

Generally, farmer's response to agricultural innovations is attributed to certain institutional factors such as extension, credit, input delivery, land tenure, and sources of information. Ogunfowora and Essang (1972); Igben (1987); D'Silva and Raza (1980) differently identified extension contact, credit availability, delivery of inputs and sources of information to be positively related to successes recorded in farmers adoption of agricultural innovations. Akanya (1989), found extension contact and credit facilities to be positively and significantly related to awareness, adoption and gross farm output of farmers. Very often,farmers are desirous of adopting new practice in fish farming but are

constrained by inadequate information, caused by the inability of extension personnel to reach fish farmers (Osuji, 1983). Hook (1983) observed that availability of farm credit was an important factor influencing adoption of recommended technologies. Mijindadi and Njoku (1985) found statistically significant association between extension contacts, membership of association, credit, input delivery and farmers' awareness and adoption of innovations. Ekpe and Obeten (2004) reported that farmers who are members of cooperative societies are usually better informed on extension innovations and obtain technical inputs more easily than farmers who are not members. Moser (1996) referred to credit as one of the accelerators of agricultural development. Awareness of a new technology can create interest in farmers which will lead to the adoption processes.

The appropriate technology should be available, simple, affordable, practicable, portable, viable and profitable for adoption (Bolorunduro and Fregene, 2000). There is also a problem of how to transfer the available technology to the small fish farmer in the rural areas in a form it will be used. Nweke and Akerhe (1983) opined that, before a technology transfer programme is embarked upon, the technology must be tested not only for its financial profitability but also for its suitability to farmer's circumstances and needs. Research findings on farmers' awareness, income and adoption reveal that certain socio-cultural variables, such as friends, neighbors, family/village structures tend to influence individual adopters in that they serve as consultants in farmer's decision to either adopt or reject farm innovations (Attahiru, 2002). According to Awogbade (1981) because of the family/village structural arrangement in which the household head acts as both the legal and political spoke person on all matters, his decisions often influence others to either adopt an agricultural innovation or not. Onazi (1973) in his study of Northern Nigeria

found among other reasons given for farmers' non-adoption of agricultural practices as reluctance to give up their old ways, and unfavorable producers prices. Williams (1969) discovered in Western Nigeria that farmers who failed to adopt the recommended practices of rice and cotton production and use of fertilizer did so because nobody in the village adopted them. Socio participation is likely to increase farmers' exposure to new information.

Laogun (1973) discovered that income level, farm size, social participation, extension contact, number of information sources used to introduced practices and extent of awareness are significantly related to adoption of recommended farm practices. Zaria (1984) and Akanya (1989) also found age to be negatively and insignificantly related to farmer's awareness and adoption of farm innovations. Voh (1984) reported a positive relationship between level of education, socio-economic status, to adoption, which of course would affect awareness, and the gross farm income of the farmers.

Onyewaku and Inbuba (1991) found that profitability of enterprise was the major reason for adoption, while lack of awareness of the technology was the limiting factor to adoption. Also Agbamu (1993), Igodan and Jabar (1993) found that farmers' knowledge of innovations made predominant contribution to adoption level, while contact with extension agents made significant contribution towards adoption with a negative regression coefficient. The income of most farmers is low and this affect the extent to which they can save. To increase production and income therefore, some form of credit would have to be provided. Lack of credit may be a disincentive to farmer's adoption of agricultural innovations because in some cases farmers are too poor to finance improved agricultural

technology (Ridd, 1968). In the same vein, Hook (1983) observed that availability of farm credit is an important fact influencing adoption of improved agricultural technologies.

2.2 Impact of Fishery Technologies Adoption on Fish Processors Livelihood

Fishery supplied more than 87% of the animal protein and more than 90% of coastal communities depend solely on fishing and fisheries related activities for their survival (FAO, 2002 and Davies, 2005). About half (47 percent) are women, mainly engaged in the post-harvest activities, handling the fish after it is caught and ensuring that this important source of nutrition reaches more than 1 billion consumers for whom fish is a key component of their diets (World Bank, 2010). Globally, the fisheries sector is likely to employ some 30 million fulltime and part-time fishers of which 90 percent are in developing countries (FAO and WFC, 2010). According to FAO (2012), the small-scale fisheries sector, including fishing and fish farming, is estimated to employ some 37 million people, of whom around 90 percent are in Asia. An additional 100 million people are estimated to find employment in associated activities that is processing, transporting and marketing (FAO, 2012).

In recognition of the huge potential for contributing to food security and nutrition, major role in the economies of developing countries as a basic source of local and foreign income, employment opportunities and enhancing socio- economic status of its populace the Government of Nigeria threw their weight to the success of fisheries industry (Tawari and Davies, 2010). In their study titled impact of multinational corporations in fisheries development and management in Niger delta Nigeria, they reported that Fishers-folk livelihood depend solely on fisheries resources, with fisheries accounting for more than

85% of the annual income. In terms of employment and income source, Raji and Ovie (2009) estimated that over 10 million Nigerians' are engaged in primary and secondary fisheries activities mainly as fishers, fish farmers, fish processors, marketers and ancillary activities. Estimates of women's participation in the fisheries workforce has shown that there are almost as many women as men employed in the fisheries sector when also including post-harvest activities (FAO, 2012). These activities serve as sources of income to the rural populace. Kaaria *et al.* (2008) investigated whether additional income from upgraded livestock and agricultural activities would be reinvested in natural resource management, finding that resources were instead devoted into expenditure on assets and basic needs. This is common with the rural poor where instead of expanding or upgrading their small businesses they spend on their basic needs. Factors such as access to assets, gendered education differentials and the nature and value of economic activities affect the way in which men and women participate and gain, even where women may not directly control assets and income, they and their households can benefit from their engagement in fishery activities, for example through better nutritional outcomes and increased food security resulting from increased aggregate household production and income (USAID, 2006).

2.3 Fish Processors Perception of Improved Technologies and Adoption

It has been reported by Agwu and Anyanwu (1996) that increases in educational status of farmers positively influence their perception and adoption of improved technologies and practices. The decision of use of technologies is dependent on how farmers perceive of technology. According to Van de Ban and Hawkin (1988) perception is the process by which we receive information or stimuli from our environment and

transform it into psychological awareness. The farmer's choice of action (decision) will depend on his evaluation of this and other outcomes, in term of his own personal perspectives. The household ultimately decides on the farming systems on whether or not to adopt technologies and how to assign resources to support it.The predominant role of technology is facilitating major improvement in agriculture productivity. Therefore, it is important to know how farmers perceived technologies for better understanding of their choice in decision of adoption or not. Technology is one of the resources for agricultural production; Rogers (1983) reported that technology is a design for instrumental action that reduced the uncertainty in the cause and effect relationships involved in achieving a desired outcome. The desired outcome is achieved when the farmer adopts the technology and puts it to use. Adoption according to Mosher (1987) is a process by which a farmer is exposed to, consider and finally reject or practice a particular innovation. Regarding adoption, farmers sometimes discover problems in putting recommendation into practice, the extent of adoption, adjustment or rejection depends on farmers' behavior (Valeraand Plopino, 1987).

In a study carried out in Niger Delta on effectiveness of Agricultural agencies in fisheries management and production Tawari (2006) found Fish culture practices and technology adoption to be poor. In the same vein Nwachukwu and Onuegbu (2007) found that adoption level of aquaculture technology in Imo State is low and the attributed it to poor economy and inconsistent Government Policy.

2.4 Poverty Status in Nigeria

Agriculture is a most important source of income to about 90% of the rural dwellers in Nigeria. The rural sector accommodates about 70% of the nation's population and employs about 75% of the labour force which contributes 40% the Nations GDP (Igbalajobi *et al.,* 2013). It has been revealed that while the proportion of the population living in poverty in smallholder farming is on the decrease in Asia, the proportion has increased in Sub-Saharan Africa in which Nigeria is inclusive (Apata *et al.,* 2009). Poverty is a universal phenomenon that affects socio-economic and political well-being of its victims whether in a developed or underdeveloped country, however, available statistics shows that poverty in poor country is absolute and more pronounced in the rural areas (Igbalajobi *et al.,* 2013). The poverty situation in Nigeria is quite disturbing as both the quantitative and qualitative measurements attest to the growing incidence and increasing depth of poverty in the country (Okunmadewa *et al.,* 2005). Household food and nutrition security relies heavily on rural food production and this contributes substantially to poverty alleviation. The bulk of the poor, some three-quarters according to a recent World Bank estimate, live in rural areas where they draw their livelihoods from agriculture and related activities.

The energy intake by Nigerians averaged 225 kilocalories a day against internationally estimated minimum of 2500 and 2800 kilocalories daily. About 13-18 million people (mostly children) also die yearly from hunger, malnutrition and poverty-related causes. Nigeria's relative poverty (appendix 2) measurement stood at 54.4% in 2004, but increased to 69% in 2010. It however remains a paradox despite the fact that the Nigerian economy is growing, the proportion of Nigerians living in poverty is increasing

every year, although it declined between 1985 and 1992, and 1996 and 2004 as shown in table 1, the proportion of the extremely poor increased from 6.2% in 1980 to 29.3% in 1996 and then came down to 22.0% in 2004 before reaching 38.7% in 2010. On the other hand, the proportion of non-poor was much higher in the country in 1980 (72.8%) compared to 1992 (57.3%). It dropped significantly in 1996 to 34.4%, falling further in 2010 to 31% (National Bureau of Statistics, 2011).

Hazoor *et al.* (2006) reported that majority of the rural poor are small-scale farmers and the poverty gap is becoming wider over the time which calls for corrective action. Consequently, targeting of rural households seems vital in alleviating poverty in Nigeria. Over 70% of Nigerians lived within the ambit of poverty (Okumadewa, 2006) and efforts are being made by government at various levels in the country to introduce improved technologies to fish farmers to enhance their level of production (Okunlola*et al.*, 2011).

Agricultural technology can contribute to poverty reduction through direct and indirect effects. These will be largely determined by the speed with which households adopt new technologies relative to others. Promoting innovative agricultural technologies for smallholders was accepted as an efficient and equitable approach to promote economic growth. Smallholders were more efficient in the allocation and use of resources (compared for example to commercial farms) and their promotion improved equity as it increased returns on assets held by the poor and puts food and cash income directly into the hands of the poor (Kydd, 2002). Due to very limited access to modern improved technologies and the general circumstance of these poor fisher folks to be able to access capital and inputs, production, processing and marketing has become a challenge for them. Assisting these

fisher folks to develop their livelihoods and food security in a sustainable manner is therefore crucial.

2.5 Overview of Fishery Sub-sector and Policies in Nigeria

The fisheries sector is estimated to contribute 3.5% of Nigeria GDP and provides direct and indirect employment to over six million people. With about 14 million liters of inland water bodies, Nigeria could be self-sufficient in fish production and in a major exporter of fish (Akankali and Jamabo, 2011). Efforts by the Government of Nigeria to develop the fisheries sector started in 1941 and programmes were put in place to; Increase fish production through input supply at subsidized rates and technology transfer and revolving loan schemes for fishermen.

Agricultural Development interventions were put in place; National Accelerated Food Production Programme (NAFPP) was an agricultural extension programme initiated in 1972; Agricultural Development Projects (ADP) in 1974; Operation Feed the Nation, launched in 1976; River Basin Development Authorities (RBDA) established in 1976; Green Revolution Programme 1980; the World Bank-funded Agricultural Development Projects. The comprehensive agricultural policy for Nigeria, with fisheries as a component, was developed in 1988 (FMAWRRD, 1988). Seven policy objectives were identified for fisheries as follows:

i. Increasing domestic fish production;
ii. Earning foreign exchange through the export of fish, especially shrimps;
iii. Developing local fisheries – based industries
iv. Rational management and conservation of fisheries resources for optimum use;

v. Encouraging the manufacturing of fish products;

vi. Providing employment to Nigerians by mechanizing the sector; and

vii. Increasing per capital income of indigenous fishers.

National programmes and projects such as the Aquaculture and Inland Fishery Project (AIFP), National Accelerated Fish Production Project (NAFPP), Fishing Terminal Projects (FTP), Fisheries Infrastructures provision/Improvement (FIP), and the Presidential Initiative on Aquaculture (PIA) were also put in place to boost the fisheries sector, (FAO, 2002). Part of the plan of government is to distribute fingerlings to small scale fish farmers free while large scale farmers will be subsidized up to 50% of the cost (FMAWR, 2008).

Nigeria is endowed with substantial marine and inland fisheries resources upon which the fisheries sector is based. The fish production in Nigeria is mainly from these sources; artisanal, aquaculture and industrial fishing (Otubusin, 2011). Total domestic production of fish in Nigeria is between 242,525 and 615,507 metric tonnes from 1981 – 2007 (FDF, 2008). In 2013 the Federal Government included aquaculture in the GES scheme and these have helped to increase production to about 420,000 metric tonnes per annum. They distributed a total of 3.6 million juveniles, 36,000 bags of 15kg of feeds and 200 water testing kits provided to fishermen in 10 States at a total cost of 1.5 billion naira. Federal Government also distributed 800 fingerlings to 840 fish farmers. Statistics show that growth in fish production is due to increased activities of aquaculture. Opportunities exist in various areas of the fisheries sub-sector, these include: Production of table size fish, Construction of fish farms, Storage, processing and preservation of captured fish and fish seed multiplication. With an estimated 10 million Nigerians actively engaged in the

upstream and downstream areas of fisheries operations in Nigeria, the contribution of the fisheries sub-sector to the nation's economy is significant, ranging from employment creation to the provision of raw materials for the animal feed industry (Osagie, 2012). Most of the populace in these areas depends predominantly on fish for food and means of livelihood. They are primarily fishermen, who also engaged in fish related activities like fish processing, hawkering, fish transportation and gear manufacture and subsistence aquaculture (Akinrotimi *et al*., 2007).

2.6 Fishery Institutes in Nigeria

Nigeria established two institutes centered on freshwater and marine fisheries resources. They are bodies established and regulated by the policies and activities of conserving and managing fisheries resources in the country. They are;

1. National Institute for Freshwater Fisheries Research (NIFFR),
2. Nigerian Institute for Oceanography and Marine Research (NIOMR).

2.6.1 National Institute for Freshwater Fisheries Research (NIFFR)

Established in 1968 as a project by the Federal Government of Nigeria with aid from the UN and was then Kainji Lake Research Project., the Food and Agriculture Organization (FAO) was named the executing agency. In 1975 FAO experts formally withdrew their participation and qualified Nigerians took over the management of what came to be known as Kainji Lake Research under the auspices of the Agricultural Research Council of Nigeria (ARCN) which was established by the Research Institutes order of 1975. The mandate of the Institute then was in the areas of: Fisheries, Wildlife, Agriculture, Limnology, and Public health, Sociology, Economics and Range

Management. These activities were extended to cover other manmade lakes in Nigeria. Due to the reorganization of some Research Institutes within the Federal Ministry of Science and Technology in 1987, the mandate of the Institute changed from multi-commodity as listed above to mono-commodity, namely Freshwater Fisheries with emphasis on Hydrology, Fish Biology, Fisheries Management, Limnology, Environment, Fisheries Technology, Hatchery Management, Aquaculture, Socio-economics, Extension Liaison services and training. The name of the Institute changed to "National Institute for Freshwater Fisheries Research" to reflect the new mandate. The activities of the Institute is Coordinated by Agricultural Research Council of Nigeria (ARCN).

2.6.2 Nigerian Institute for Oceanography and Marine Research (NIOMR)

The Nigeria Institute for Oceanography and Marine Research (NIOMR), an offshoot of the Marine Research Division of the Federal Department of Fisheries was established in November 1975 by the research institutes establishment order of 1975. The institute mandate is to conduct research into resources and physical characteristics of the Nigerian territorial waters and high seas beyond.

Relevant Research Institutes in Nigeria have developed technologies that will go a long way in enhancing fish farmers' productivity and profitability, as well as prevent post-harvest losses e.g. Nigerian Institute for Oceanography and Marine Research (NIOMR), Victoria Island, Lagos, Nigerian Stored Products Research Institute (NSPRI), Ilorin, Kwara State and the National Institute for Freshwater Fisheries Research, New Bussa, Niger-State (NIFFR). Some of these technologies in aquaculture and fish technologies include;

1. Genetic improvement of catfish through acquisition of germ plasm of promising strains from different ecological zones in Nigeria;
2. Development of mass production techniques for the fingerlings of clarias gariepinus and the hybrid of clarias spp. And heterobranchus sp;
3. Development of fish feeds for the fish farms industry;
4. Development of ponds construction techniques in different ecological zones in profitable farming;
5. Pioneered canning of tuna, bonga, sardinella and drift fish (arioma spp) in Nigeria;
6. Production of fish meal, a high protein concentrate for fish and poultry;
7. Ice fish block, designed to improve the quality of fresh fish up to 54 hours (hrs) with ice block ratio 1:4(1kg ice block to 4kg of fish). Design, fabrication and patented fish smoking kiln with a capacity of 250kg of fish for 6 hours;
    - Modified drum oven, Altona kiln, banda kiln, solar tent e.t.c
    - Detachable fish smoking kiln enabling hygienic collection of oil from smoked fish
    - 3-in-one kiln that uses electricity, gas or charcoal

2.7 Fish Processing Technologies in Nigeria

Fish has been consumed by large portions of the populations in Nigeria and it has become a staple diet. It contributes to the animal protein supplies of many communities in both industrialized and developing world (Adewolu and Adeoti, 2010). Fish is one of the most delicate of all staple commodities especially in the tropical climate regions of the world (Abolagba and Nuntah, 2011). When it is not consumed within a day of harvest it

spoils and it becomes unfit for human consumption, except it is properly handled (processed). Over 80% of fish harvested in Nigeria is preserved by various methods of curing to prolong the shelf life of the fish. The principal processing methods are smoking, drying, salting, fermentation, roasting, boiling and frying or any combination of these processes (Adepegba, 2001; Eyo, 2001; Whittle, 2002). Smoking is a method of preserving fish which combines three effects; preservative value of smoke, drying and cooking (Clucas, 1982; Asita and Campbell, 1990). Operations involved in smoking of fish are similar and the method has the effect of imparting pleasant flavor to the product besides the preservative effect of the smoke (Ako and Salihu, 2004; Tull, 1997). Fish smoking in the tropics is conducted in smoke houses and smoking ovens or kilns (Eyo, 2001). The longer fish is smoked, the longer will be the shelf life (Arthur and Osei-Somuah, 2004; Abolagba et al., 2002; Eyo, 2001; Eyabi, 1998). Drying or dehydration is used to describe the process of removing water by evaporation. Drying is effected by lowering the water vapour pressure of the fish to a level which microorganisms can no longer grow (Eyo, 2001; Ako and Salihu, 2004; Bolaji, 2005). Salting disturbs the slime on the surface of the fish, which also inactivates the surface bacteria (Abolagba, 2006). Common salt (Nacl) retards the activity of bacteria, enzymes and chemicals in fish (Eyo, 2001). Three methods of salting commonly practiced are dry salting, wet salting and brine salting (Whittle, 2002; Eyo, 2001; Clucas 1982). These methods of preservation enhance the shelf life of the fish and make it highly acceptable to most consumers. Processing of fish adds quality and value to the product thereby enhancing the marketability and suitability for export (Areola, 2011).

Smoking as a method of preservation of perishable foods dates back to civilization. Fish and fishery products are one of the most perishable of all staple commodities. To prolong the shelf life of fish, fish is preserved by smoking. Smoke is generated from wood by burning. Smoke has bacteriostatic, bactericidal and antioxidant functions while heat generated from the wood has dehydrating effect on the fish (Eyo, 2001). The combinations of these processes give fish dry effect. Hence a well smoked fish can be kept in storage for months without undergoing spoilage.

There are different types of local ovens being used depending on the location. In the northern part of the country, Banda is used generally while in the south, it ranges from simple pit ovens to drum oven. Improved smoking kilns such as Chokor Kiln, Altona/Watanabe Smoking Kiln, Ivory Coast Kiln, Magbon Alade Kiln, Kainji Gas Smoking Kiln, Improved traditional smoking kiln and Modified Drum Kiln (MDK) among others have been invented.

The most important advantage of these simple ovens is the low capital cost. However, many disadvantages have been reported which include:

I. Inefficient utilization of fuel wood
II. Poor quality of fish due to lack of control over the temperature of the fire and the density of smoke (Clucas, 1995) among others.

2.7.1 Chokor kiln

The kiln originated from Ghana in Chokor village from where it derived its name and is an improvement on the traditional smoking kiln. The kiln is rectangular in shape and has a mud, cement or back wall of internal dimensions of 0.7m x 0.7m x 0.7m. The top of the

wall is flat to enable the wooden frame trays sit snugly against them. This version has two chambers and each chamber has centrally placed stoke hole, 38cm high and 38cm wide. The wooden smoking tray has dimension 0.8m x 0.8mx 0.7m and consists of chicken wire mesh nailed to the wooden frame. The smoking trays have a pair of handles on the opposite for lifting together. Up to 15kg of fish can be smoked on each tray. During smoking, the wooden trays with fish are stacked to enhance the capacity of the kiln. Up to 5 trays may be stacked to form a chimney in which heat and smoke circulate constantly (Eyo, 2001). The last tray is then covered with a ply wood sheet till the smoking process is complete. The rate of adoption of this kiln in Nigeria is high.

Advantages of Chokor Kiln

1. It is fuel efficient
2. It is easy to operate and maintain
3. Produces evenly smoked fish which fetches a high price in the market
4. High batch processing capacity
5. Durable if protected from rain

2.7.2 Improved Banda (IMB)

The improved Banda is a modification of the traditional rectangular mud-type smoking kiln (Adelowo *et al.*, 1998). The structure is simple and can be constructed by the local fish processors. Its simplicity and efficiency in utilization of fuel wood accelerate its adoption by the local fisherfolks (Eyo, 2001). It is a rectangular structure with a dimension of 120cm x 70cm x 70cm. the fire box is reduced in size to allow limited air ingress and escape of smoke. The dimension is 30cm x 30cm. the significant feature of the kiln is the

presence of a damper, a perforated metal plate that prevents direct contact of fire with fish, thus fish loaded on the bottom trays close to the fire do not get charred. It is covered with framed zinc together with a chimney that serves as escape route for excess smoke. The improved Banda is equipped with 3 trays where fish is arranged for smoking. The fish is prepared and loaded in the tray. After loading, firewood is ignited in the firebox and the smoking operation commences.

Advantages of Improved Banda

1. Using this kiln, fuel wood consumption is reduced to 52% compared with the traditional smoking kiln
2. The quality of the smoked fish is also high and acceptable to consumers
3. It Is less labour intensive
4. It is cheaper to construct than most improved kilns.

2.7.3 Modified Drum Kiln (MDK)

This improved processing technology was pioneered by NIFFR and NIOMR in the 1980s, this smoker is targeted at small-scale fish processors. The technology is used for smoke drying; it is an adaptation of traditional mud kiln. The modified drum oven is light and portable. The firing chamber, the smoking racks and the chimney all ensure efficient smoking of fish more than the traditional drum oven (Bolorunduro, 2004). The kiln is made from a 400 litre capacity drum with a length of 90cm and diameter 58cm.he drumis cut open midway using a motorized welding nozzle. The base of the drum is cut open midway using a motorized welding nozzle. The base of the drum is used as the combustion chamber with the firebox measuring 22 x 22 cm^2 cut out from the base. An internally built

damper made of perforated metal plate is installed 1 cm above the fire box. The smoking chamber is separated into 3 compartments 10m above the damper. The first rack is installed covered with a chicken mesh to form the first smoking chamber. In the second and third compartment of the drum are fixed racks and chicken mesh to serve as the second and the third smoking chamber respectively. Above the smoking chamber, the kiln cover is attached at an angle of 40^{o} above the cover; a metal pipe of 4 cm was incorporated to serve as the chimney.

Advantages of Modified Drum Kiln

1. It is fuel efficient compared with the traditional drum kiln
2. Produces good quality fish that command high price and is acceptable to consumers
3. It is less labour intensive
4. It is very simple to construct
5. It is cheaper to construct than most improved smoked kilns
6. It is portable and can be carried on fishing boats.

2.7.4 Altona Kiln

The altona type of oven is suitable for large quantities of fish and has a superior racking system for holding fish. It consists of a wooden smoke unit placed above a fire box. The fire box is built from clay or sundried clay blocks. Cost of constructing this kiln is expensive compared to the modified drum oven.

2.8 Constraints Militating Against Fish Processors in Nigeria

Constraints militating against fish processors in their participation in agricultural processing are many, some of which are socio-cultural and economic in nature. Cost,

visibility, complexity, divisibility, compatibility, utility, group action, level of education, risk and uncertainty, conflicting information, loss of flexibility, physical and social infrastructure have been identified by (Bembridge, 1991; Vanclay, 1992; Ogunbameru, 2001) as factors influencing the adoption process. Fish processors are more constrained in terms of access to credits and information technology. The key Constraints in Aquaculture Value Chain in Nigeria as reported by the FMARD, (2011) include; insufficient development of the fish processing, under-utilization of the seafood processing capacity, insufficient knowledge, technology and investment for aquaculture products for storage and transport, insufficient food safety and traceability standards, unsustainable food safety practices along the value chain, hinders entering into higher value markets, lack of access to microcredit and insufficient investment and lack of information.

In a study conducted by Ibrahim *et al.* (2011) they found that women who are into processing fish in Nasarawa State lack collateral to obtain loan from banks, modern fish processing facilities, lack of extension service, inadequate storage facilities, poor marketing arrangement and delay in fresh fish supply are some of the constraints in the industry. Ineffective or inappropriate fish processing technologies, poor harvesting and inefficient post-harvest handling practices, bad roads, bad market practices and inadequate or lack of proper storage facilities are some of the factors responsible for high post-harvest fish losses (Davies, 2005).

Processing and marketing activities provide the greatest opportunities for employment within the fisheries industry. The main concern of small subsistence households is to secure a steady living year-round for the family. Fish supply has been one of the problems militating against adequate fish consumption, in most markets in Nigeria,

fish is sold to consumers as frozen or ice fish, cured (smoked) fish, sundried fish and as fresh fish either from a cultured pond or from the wild.

Transportation and distance from the point of sale to the final consumers have affected the quality and cost of fish products (Gittenger, 1984). Udong, *et al.* (2009) reported institutional constraints such as lack of infrastructure, financial assistance, market information and Government/NGO's support and cultural constraints such as polygamy and patriarchy affect all the fish traders.

CHAPTER THREE

3.0 THEORETICAL FRAMEWORK

The theoretical framework is the structure that can hold or support a theory of a research study. The theoretical framework introduces and describes the theory which explains why the research problem under study exists. The concept of impact assessment and adoption and diffusion theory was used to analyze this study.

3.1 Concept of Impact Assessment

Impact assessments are carried out to evaluate the consequences of individual projects. Impact is synonymous with end result or outcomes. Impact assessment can focus on specific themes such as economic impact assessment, environmental impact assessment, social impact assessment and gender impact assessment. This impact assessment is used in different ways and for different purposes.

Mosley (1997) saw impact assessment as the grandchild of welfare economics, by way of social cost benefit analysis. He argued that there are three questions which the authors of impact assessment need to answer;

i. What was the net benefit conferred by the intervention or projects ie the difference between the with- project and with-out project situation?
ii. How did the benefits divide up between the different parties affected by the interventions
iii. By what causal process did the benefits and cost revealed by 1 and 2 materialize? What are the lessons for analysis of future interventions of this type?

These questions help in the understanding of what to assess of the intervention or project and it is aimed at predicting impacts at an early stage in the intervention or project. Manyong *et al.*(2001) viewed impact assessment as a critical component of agricultural research that helps to define priorities of research and facilitate resource allocation among programs, guides researchers and those involved in technology transfer to have a better understanding of the way new technologies are assimilated and diffused into farming communities and show evidence that clients benefits from the research. Sanginga *et al*. (1999) explained that impact analysis deals with the investigation of changes that occurred on the people's life as a result of the programme or interventions. Impact assessment in agricultural research tries to find out how far or how well the introduction of technologies has successfully met the needs and priorities of household or target population. It is an evaluation that looks at intervention output on the target beneficiaries. In agricultural research impact assessment is viewed as an important activity that ensures accountability maintain credibility and improve the decision making processes and the capability to learn from past experience (Alene *et al.,* 2006)

However, impact assessment on benefits of agricultural technology adoption on beneficiary's income is difficult to evaluate and this is because of the complexities involved in understanding the link between agricultural technology and rural livelihood. This is because rural people generally have a lot of coping strategies of combining their assets and agricultural technologies to attain their life goals of food sufficiency and improved livelihoods e.g. the beneficiaries of fish processing technology might be involved in other forms of business apart from fish processing which could still improve his/her level of income. The impact of the fish processing technology if carried out may

not give a true impact of fish processing using modified drum oven on fish processors income and level of living.

3.2 Adoption and Diffusion Theory

Adoption refers to the decision to use a new technology or practice by economic units on a regular basis. The classical theory of adoption was first introduced by Gabriel Tarde in 1890. Tarde conceptualized the patterned communication process as social imitation or the duplication of something new by members of a community (Adekoya and Tologbonse, 2011). Researchers from sociology; economics, political sciences, communication, and public health have studied the adoption of innovations (Wejnert, 2002). Adoption as defined by Rogers (1983) as the use or non-use of a new technology by a farmer at a given period of time. Adoption refers to the decision to use a new technology or practice by economic units on a regular basis. The question of why and at what rate individuals adopt a particular technology has received a good deal of attention in scholarly literature.

However, Everette Rogers became the known scholar in the area of adoption and diffusion through his book “Diffusion of innovations” written in 1962. Rogers pointed out that adoption theory is not a single but all encompassing theory which is made up of several theoretical perspectives that relate to the overall concept of adoption (Rogers, 1995). The diffusion of innovations is the most widely used framework to explain and predict adoption of new technologies. Rogers defines diffusion as “the process by which an innovation is communicated through certain channels over time among the members of a particular social system; this process includes both planned and spontaneous spread of new ideas” (Haider and Kreps, 2004). Diffusion refers to spatial and temporal spread of the new

technology among different economic units. Rogers (1995) presented four adoption theories;

- 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.
- Individual Innovativeness theory*;* Individuals who are risk takers or otherwise innovative will adopt an innovation earlier in the continuum of adoption/diffusion.
- 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.
- Perceived Attributes theory*;* There are five attributes upon which an innovation is judged: that it can be tried out **(trialability),** that results can be observed **(observability),** that it has an advantage over other innovations or the present circumstance **(relative advantage),** that it is not overly complex to learn or use **(complexity),** that it fits in or is compatible with the circumstances into which it will be adopted **(compatibility).**

Van den ban and Hawkins (1996) explained further the adoption process as:

a) "Awareness" first hear about the innovation

b) "Interest" see further information about it

c) “Evaluation” weighs up the advantages and disadvantages of using it.

d) “Trial” tests the innovation – on a small scale for you.

e) “Adoption” – apply the innovation on a large scale in preference to old methods.

The adoption process according to Rogers does not always follow a sequence in practice. This is because there is clear evidence that the “knowledge” and “decision” stages exist, but evidence for other stages is much less clear. Williams (1978) explained the adoption process with the following steps: awareness, interest, desire, conviction, action, satisfaction. Unless satisfaction comes from the first stage which is awareness and all the others as they are adopted, the individual will not be keen on making other changes. Hall and Kahn, (2003) observed that the most important thing about this kind of decision is that at any point in time the choice being made is not a choice between adopting and not adopting but a choice between adopting and deferring the decision until later. Decision in practice may often be made in such a less rational and systematic manner. Rogers (1995) further categorized adopters in terms of timing. This type of analysis produces a normally distributed adoption curve. This curve classifies adopter into five categories: Innovators, Early Adopters, Early Majority, Late Majority, and Laggards. The innovators are the risk takers and also lead the way interms of adopting a technology. The early adopters help spread the word about the innovation or technology to others. The early majority and late majority are the potential adopters. The laggards are skeptical and resist adopting until absolutely necessary and most times they never adopt the innovation (Rogers, 1983). If farmers are convinced of the value of an innovation, they will adopt (Kamarch, 1999). The more a new idea is compatible with past procedures, techniques and values of an organization, the more likely the organization are to adopt it. Rogers (1983) further

explains that the attributes of the innovations are influence in the rate of adoption. Innovation attributes include: relative advantage, compatibility, trialability and observability as mention above. However Dearing (2004) argues that one of the three reasons that lead potential adopters to adoption is "what they think about the innovation." The most economically logical reason for farmers' adoption of a particular innovation or new farm practices would definitely be the expectation of higher yields and consequently increased income (Omolehin, *et al*., 2007).

Rogers and Shoemaker (1971) broke down the diffusion process into four stage; innovation, communication, social structure and time span. They further described the adoption process as a mental process through which an individual passes from knowledge of innovation to a decision to adopt or reject the innovation. Understanding the farmers and their environment and determining the appropriateness of farm innovation to these situations are prerequisite to adoption of improved farm technology. The basic principle of the diffusion of innovation theory is that access to information regarding a new technology is the foremost factor affecting the adoption decision process (Hooks et al. 1983). Adoption spreads faster when there is information and if a new technology is known to be profitable or if others are using it. The duration of adoption of a technology differ among economics units, regions and attributes of the technology itself.

3.3 Critique of Adoption Theories

It remains difficult for researchers to state with a reasonable degree of certainty how agricultural technologies are adopted after they are released (Adekoya and Tologbonse, 2011). Rogers (1995) observed that the application of innovation of diffusion theory in developing countries had undesirable consequences. This problem stemmed from the

assumptions that benefits resulting from the adoption of innovations spread are homogenous. Experience from Latin America showed the gap inequities actually widened. Aggregate statistics for development projects may show improvement in elements like production, but commonly the farmers most in need of help received little benefit (Mamman, 2014).

Technologies are static as such the model did not take into cognizance that there are changes and modifications in some of the technologies developed and also to attract more adopters. Adoption studies in Nigeria have pointed out that there are differences between findings in the advance nations and most of developing nations (Reynolds, 2001; Holden 2002). The starting point of adoption and diffusion process is awareness which Reynolds (2001) noted that the assumption is partial conceptualization. Also the assumption that certain values are common in all the societies is baseless. Adoption studies tend to be concerned mainly with practices and ideas that increase production, profits and ensure greater efficiency thereby raising the doubts about application to non-profit oriented items and ideas which are often interwoven with economic activities in developing countries like Nigeria.

The Adoption theories assumed that farmers have access to sources of relevant information. This assumption is based on condition prevailing in technologically advanced nations and disregards the inadequacies of communication facilities in developing countries for example it is a fact that people living in the rural areas lack social amenities like electricity.

Adoption theory assumption is that changes required for adopting a given practice are significant and this is based on the structure of economic enterprises in industrialized

countries and this disregards the fact that a farmers mode of production in developing countries is not only an economic decision but equally takes cognizance of his status as a member of a network of kinship, religious and political groupings. Thus, a single change can generate a chain reaction for farmer in the social system.

Furthermore, the theory assumed the existence of sufficient and strong infrastructure to support the new practices. In Nigeria, most innovations have failed due to the absence of supporting infrastructural facilities required for the adoption of these innovations. Many innovations and ideas failed to be successfully adopted because they failed to be adaptable and adapted to local condition in particular regions in which they are introduced (Ekong, 2003).

The distance between the change agent and their clients in developing countries is not the same with the one existent in advanced countries such as United States and Britain. This social distance has often blocked communications between change agents and the fish processors source of information on fish processing technologies. For example developing countries like Nigeria find it difficult to effectively communicate innovations to the farmer's reason been that the farmer ratio to change agent is about 1:3000 in most states extension delivery is always not efficient (NAERLS, 2014). Therefore, this perspective was a useful guide for understanding the impact of adoption of modified drum oven fish processing technology on income and level of living of fish processors.

3.4 Conceptual Model

Conceptual models are often used to clarify the variables being studied and to illustrate the hypothesized relationships between the variables which would form the basis

for statistical verification of relationships. In this study,it is postulated that socio-economic and institutional variables will influence the adoption of modified drum oven fish processing technologies. The study looked at modified drum oven fish processing technology. The conceptual model is represented as follows:

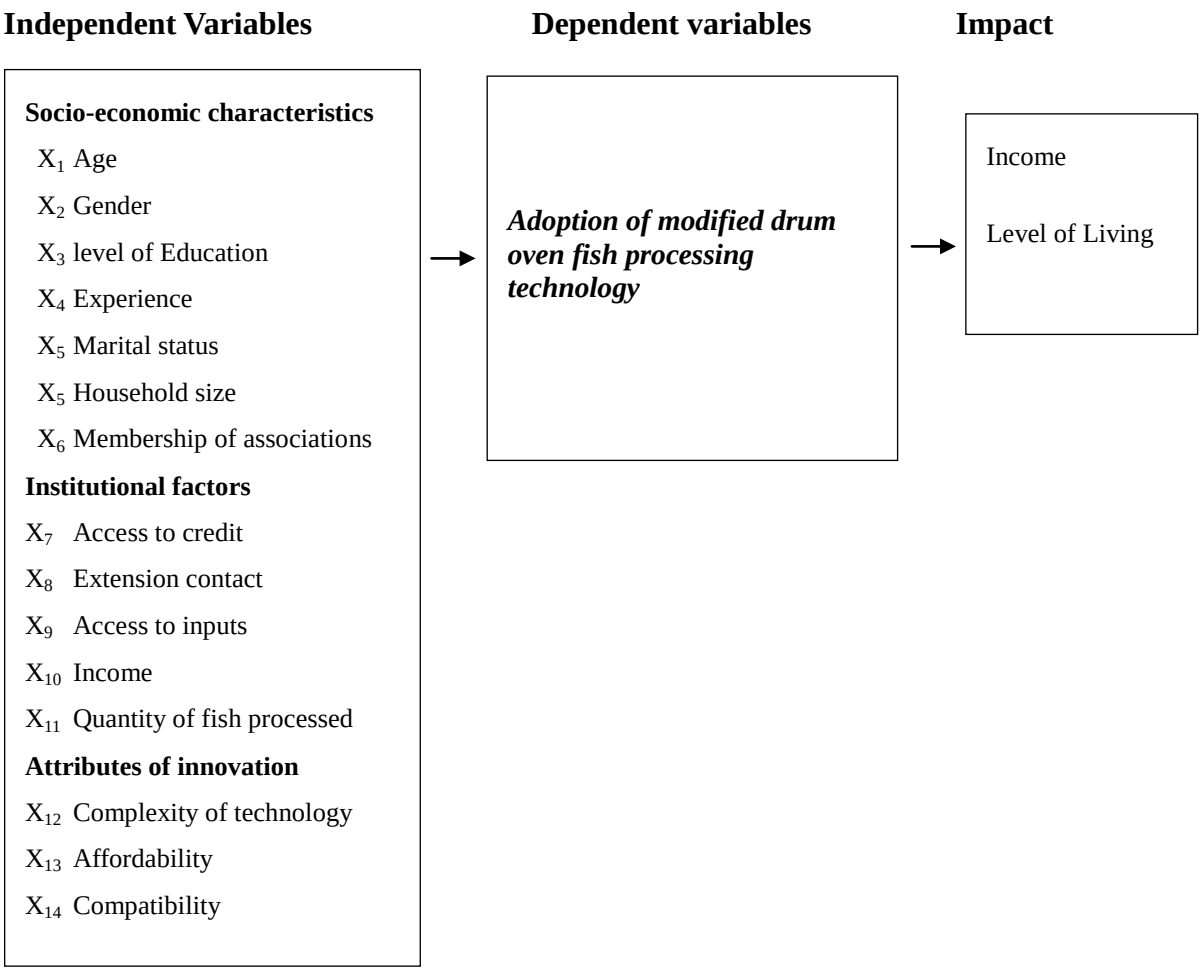

Figure 1: Model of the impact of adoption of modified drum oven technology on income and level of living of fish processors in Niger State Nigeria

CHAPTER FOUR

4.0 METHODOLOGY

4.1 The Study Area

The study was conducted in Niger State of Nigeria. Niger State was created in 1976 from the then North Western State bifurcation into Niger and Sokoto States. It covers a total of 76,000sq.km land area, which is about 9 percent of Nigerians total land area. Niger State is located between latitudes $8^0$20N and $11^0$30N and longitude $3^0$30E and $7^0$20E. The State is bordered to the north by Zamfara State, northwest Kebbi State, to the south by Kogi State, southwest by Kwara State while Kaduna and the Federal Capital Territory border the State to the northeast and southeast respectively. The State has twenty five Local Government areas (25) these include; Agaie, Agwara, Borgu, Bosso, Chanchaga, Edati, Gbako, Gurara, lavun, Kontagora, Kagara, Katcha, Lapai, Paiko, Magama, Mairiga, Mashegu, Mokwa, Munya, Tafa, Rafi, Rijau, Shiroro, Suleja and Wushishi. The major tribes in the State are Gbagy, Nupe and Hausa other tribes include Koro, Kambari, Kamuku, Pangu, Bassa, Fulani, Dukawa, Gade, Gwandara, Mauchi, Ayadi, Ingwai, Dibo, Kadanda, Gulengi, Abashiwa, and Shigini.

The State has two distinct seasons the dry and wet. The annual rainfall varies from about 16,000m in the south to 1,200m in the north. Mean maximum temperature remains high throughout the year to about 32^0F, particularly in March and June, lowest temperature occurs usually between December and January. The state is endowed with so many streams and rivers which make it suitable for fishing activities. The State has a population of about 3,954,772 (2006 census), the projected growth rate of 3.2% gives 5,093,746 as

estimatesfor 2015. Agriculture is the main stay and many of them are engage in farming with about 80% of the population depending either directly or indirectly on it for their livelihood. The agricultural activities include crop production, fishing and animal rearing.

The combined surface area of all the freshwater bodies located in the state is approximately 436,196 hectares and the potential annual fish yield from these water bodies has been estimated at about 63 tons in 2008 (Niger State Ministry of Agriculture, 2014). Fisheries sector contribution to Nigeria's total GDP since 2000 was growing at the rate between 0.2 to 0.5% annually (FISON, 2014). In 2004, exportation (mainly to the United States and Europe) was estimated at about 7000 metric tons in volume valued at about USD53 million. Prepared and preserved fish have nearly doubled their share in total quantity traded, going from 9% in 1980 to 16% in 2010 (Akande *et al.*, 2014). According to the Federal Fisheries Department (FDF, 2008), there are about 10 million individual earning livelihoods along the fisheries value chain and fisheries sector is the highest revenue-earning department in the Federal Ministry of Agriculture and Rural Development.

The State is divided into three (3) zones for agricultural purposes. They are zone A, B and C. Niger State has abundant fishing potentials which are predominant in 8 LGAs namely: Shororo, Borgu, Gbako, Mokwa, Lavun , Edati, kacha and Agaie. The commonlyprocessed fish in the State are

i.Heterotis Niloticus (bargi),

ii.Oreocromis Niloticus (tilapia),

iii. Clarias Gariepinus (Catfish, Tarwada),

iv. Lates Niloticus (Giwan ruwa).

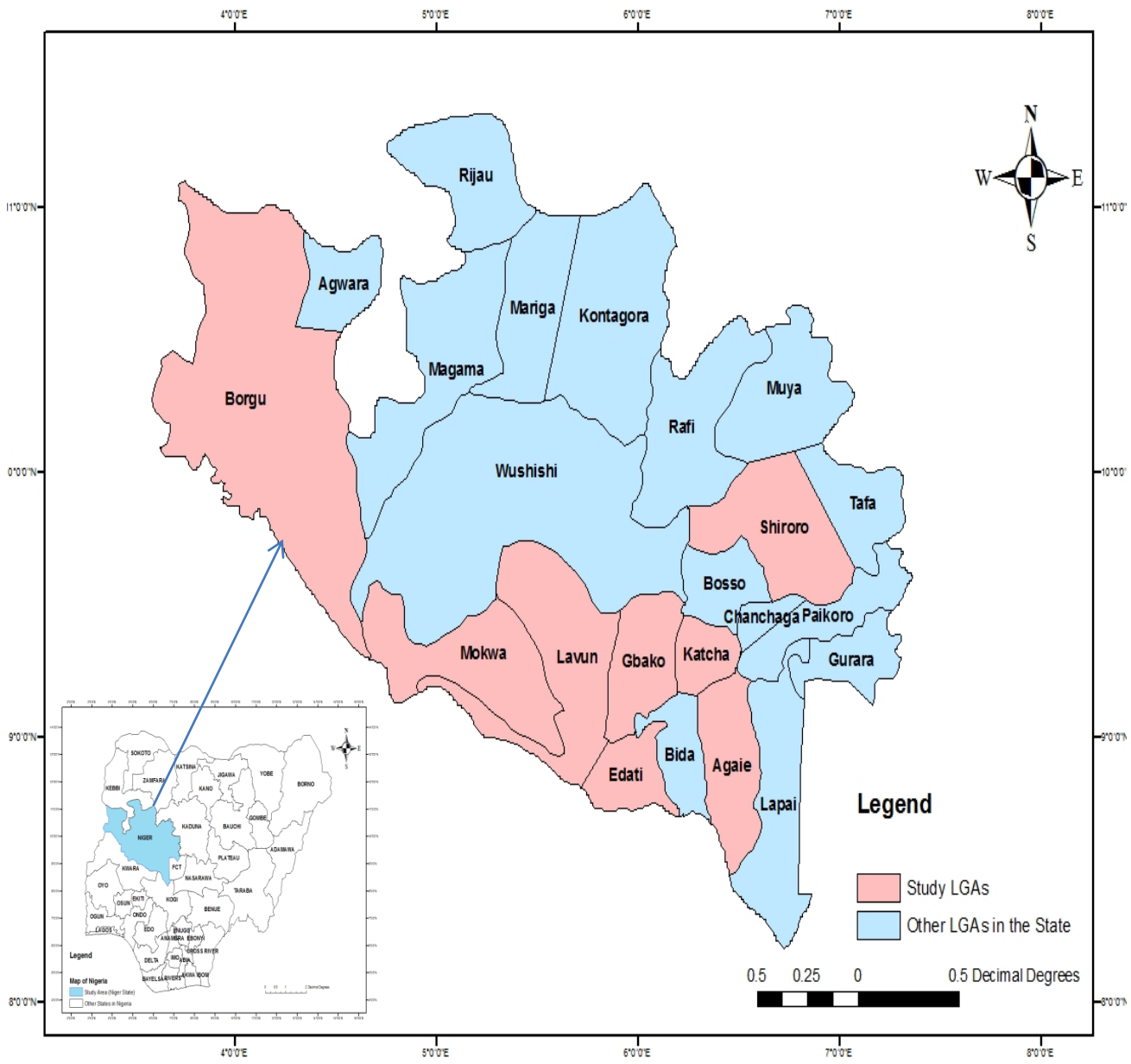

Fig 4.2: Map of Niger Stateshowing theStudy Area

4.2 Sampling Procedures and Sample Size

Niger State has 25 Local Government Areas (LGAs) and eight(8) LGAs are actively engaged in fish processing activities as reported by Niger State Agricultural and Mechanization Development Authority (NAMDA) during a recognizance survey.NAMDA is divided into three (3) zones namely: A, B and C. All the three ADP zones were used for this survey and the target population was fish processors who use either modified drum oven or traditional methods of fish processing technologies. Most of the fishing and fish processing activities are concentrated on zone A of the State as such many of the respondents were selected from zone A. Multi-stage sampling technique was adopted for this study. The first stage involved the purposive selection of all the eight (8) Local Government Areas wherefishing and fish processing activities arepracticed. Second stage involved the purposive selection of two villages from each of the eight (8) LGAs because of the prevalence of fish processing activities in the villages making a total of 16 villages. The third stagewas the random selection of respondents due to the fact that there was no comprehensive list of fish processors in the NAMDA office. In each village visited the fish processors were gatheredat the village heads' office and numbers were given to each of the respondents. In each village a total of twenty (20) respondents were selected through random sampling technique. At the end a total of 320 fish processors were selected. The fourth stage involved the segregation of the processors into two groups of adopters of modified drum oven fish processing technology (164) and another group of non-adopters who used traditional fish processing technology (156). The reason the disparity in respondents is that in some villages there were few fish processors using traditional fish processing technology while other villages had more.

Table1: Sample Frame and Sample Size

LGA	Village	Zone	Sample size	Adopters	Non Adopters
Agaie	a. Baro b. Loguma	A	40	20	20
Borgu	a. Wawa b. Fakwa	C	40	21	19
Edati	a. Rokota b. Ganzhe	A	40	20	20
Gbako	a. Edoshige b. Ndagbachi	A	40	20	20
Kacha	a. Kacha village b. Kakapungi c.	A	40	20	20
Lavun	a. Chanchaga b. Jimadoko	A	40	20	20
Mokwa	a. Rabba b. Bitagi	A	40	23	17
Shiroro	a. Gwada b. Zumba	B	40	20	20
Total	**16**		**320**	**164**	**156**

4.3 Data Collection

Data for the study were collected from primary sources. The primary data were collected through the use of a structured questionnaire which was administered to fish processors using modified drum oven and traditional methods of fish processing in the study area. Extension agents fromNiger State Agriculture and Mechanization Development Authority(NAMDA) and NAERLS were used as enumerators in the administration of the

questionnaire. The data were collected from May to July 2015 and the questionnaire captured the socio-economic characteristics of the respondents such as age, gender, marital status, level of education, household size, years of experience, and membership of cooperative/producer groups, access to credit, income from farm and off-farm activities, assets owned, quantity of fish processed, amount borrowed, and source of information. Data on reasons for joining groups/association, adoption and non adoption of modified drum ovenfishprocessing technologywere collected.

4.4 Analytical Tools

Analytical tools used in this study include descriptive statistic (frequency, percentage, mean), and inferential statistics (Multiple Regressionand Z statistics) were used to analysis the objectives of the study.

4.4.1 Descriptive Statistics

Descriptive statistics such as frequency distribution, percentage, and mean were used to achieve objectives i and v.

4.4.2 Z -statistics

This was used to achieve part of objectives iii and iv of this study. It is based on comparison of the means of two groups especially when the sample size is larger than 30. It was also used to test hypotheses i and ii of the study. The Z-statistic is expressed as follows:

$$Z = \frac{\overline{X_1} - \overline{X_2}}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \quad \text{..... (1)}$$

Where Z = calculated Z value

$\bar{X}_1$ = Mean income and level of living of the adopters ofmodified drum oven fish processing technology

$\bar{X}_2$ = Mean income and level of living of the non-adopters ofmodified drum ovenfish processing technology

S_1= Standard deviation of the adopters of modified drum oven fish processing technology

S_2 = Standard deviation of the non-adopters of modified drum oven fish processing technology

n_1= Sample size of the adopters of modified drum oven fish processing technology

n_2 = Sample size of the non-adopters of modified drum oven fish processing technology

4.4.3 Logit Regression model

Logitregression analysis was used to determine the contributions of socio-economic, institutional factors and attributes of the technology influencing adoption of modified drum oven fish processing technology in order to achieve objective ii of the study.

The equation form of the model is specified as:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}Xx_{11} + b_{12}X_{12} + b_{13}X_{13} + b_{14}X_{14} + \mu$$

Where:

Y= Technology adopted by respondents (1= adoption, 0= non-adopted).

X_1= Age of the respondent (years)

X_2= Gender (male=1, female=0)

X_3= Marital status (Single, married, divorce, widow)

X_4= Fish processing experience (years)

X_5= Level of education of the respondents (years)

X_6= Household size (number)

X_7= Membership of cooperatives (Years of membership)

X_8= Extension contact (Yes=1, No=0)

X_9= Access to Credit (Naira)

X_{10}= Processing Output of Fish (Kg)

X_{11}= Complexity of technologies (simple=0, complex=1, very complex=2)

X_{12}= Affordability (cheap=0, moderate=1, expensive=2)

X_{13}= Compatibility (not compatible=0, compatible =1, very compatible =2)

X_{14}= Income (Naira)

μ = Error Term

4.5 Definition and Measurement of Variables

4.5.1 Independent variables

Age: This is the actual number of years an individual spent from birth to the time of conducting the study. Age is believed to be capable of influencing individual's interest, perception, view and conduct. It is expected that age will influence adoption or non-

adoption of modified drum oven fish processing technology that is the older the respondents the greater the adoption. Age was measured in years.

Gender: This refers to sex of respondents either male or female. In some agricultural activities it has been observed that women are more involved than men especially in the aspect of processing and sales. Social norms, sanctions and proscriptions frequently affect an individual's ability to enter labor markets, acquire productive assets, and invest in their own or other human capital, lend and borrow money (USAID, 2006). It was highlight the gender issues in the fisheries sub-sector and it will be measured by dummy variable male =0, female= 1.

Education: This is the acquisition of knowledge through formal or informal means of schooling. Education is expected to influence individuals have access to different sources of information on technologies. High literacy level will enable farmers to understand the intricacies of new techniques for production and also predispose them to adopt and use improve farm practices (Oluyole, 2005). Respondents were scored on number of years spent in attending formal or informal education. Total number of years constituted the respondents score.

Household Size: This is the total number of people living in one house. Large household size stands the chance of getting to know of new technologies faster than small ones due to interaction by various members of the family. This was measured by the number of wife/wives, children and also dependents (relatives, workers).

Extension contact: Extension contact helps in creating awareness, highlights the benefits of improved technologies. It is expected that the higher the number of contact by extension agents to the respondent, the more he utilizes the extension information and adopt improved technologies. Extension contact was measured based on the number of visits. Each visit to the respondent was scored, as 1 and the total was calculated.

Years of fish processing experience: Refers to the years in which the fish processors are intofish processing activities. It is assumed that having more years of fishery experience enables fish farmers have more information about the industry. It was measured in years.

Membership of cooperatives: Cooperatives solve the general economic problem of under or over production, business uncertainty and excessive costs (Nembhard, 2014). Other issues such as provision of rural electricity, affordable health, access to affordable credit and banking services, affordable housing can be addressed through membership. Membership is expected to improve the income and level of living of its members. This was measured using dummy "yes" or "no" response.

Access to credit: This refers to the amount of money borrowed from lending agencies (banks, governments, friends, relatives and money lenders) by the fish processors to sustain the business, which involves purchase of equipments, inputs and payment of extra labour. One of the important factors that influence adoption of innovation is finance. It is expected that adoption of technologies and access to cash/credit from formal and informal sources would be significantly related. It was measured by total amount of money borrowed.

Processing output of fish: Scale of operation is a common variable examined in adoption studies and often is a good proxy for wealth/ standard of living. The aprior expectation of processing output is that as the output increases the income of fish processors increases. This was measured in naira (₦).

Complexity of technology: Complexity of technology can hinder fish processors from adopting it even if it is cheap. The *apriori* expectation is that the simpler the technology the greater the adoption. This was measured by composite index (2, 1, 0), Very complex, Complex and Simple, respectively.

Cost of technology (affordability): The adoption of any technology is expected to be dependent on cost of the technology. Technologies that are capital intensive are only affordable by wealthier farmers (El Oster and Morehart, 1999), and therefore adoption is limited to farmers that can pay for the technology. Technologies that cost less are more likely to be adopted rapidly. It was measured using composite index (cheap = 0, moderate = 1, expensive = 2)

Compatibility: Compatibility of technology can hold back a user from adopting the technology or innovation. The *apriori* expectation is that the more a innovation is compatible the greater the adoption. This was measured by composite index (not compatible=0, compatible =1, very compatible =2).

Income: This is the total average amount of money (Naira) derived from the sale of processed fish by the processors. To measure this, each respondent was asked to estimate how much he/she got from the sale of the fish at a given year (2014). Income unit of measurement wasin naira (₦).

4.5.2 Dependent variables

i. **Adoption:** This is the continuous use of modified drum ovenfish processingtechnology by the fish processors. Thisimproved processing technology was pioneered by NIFFR and NIOMR in the 1980s. The modified drum oven requires low capital investment and it's easily built by fish processors. The adoption score for each respondent was measured as 1 for adopting and 0 for not adopting.

ii. **Output:** Refers to the fish output obtained by the respondents after adopting the technology. It is assumed that small scale fish processors may likely adopt a technology especially if the innovation requires small cash investment. The aprior expectation of output of fish is that as the output increases the adoption of modified drum oven fish processing technology increases. This was measured in kilogram (Average total kg).

iii. **Level of living:** This refers to possession of durable assets of the fish processors after sales of output of fish. These include houses (mud or zinc roof), farm land, electronics, and furniture, animals (cows, donkey, and chicken). It was measured by the amount of all items possessed by the respondents as of the time of visit and the present market value was estimatedand was summed up and added to form an average income to represent their possible level of living. The unit was in naira (₦).

CHAPTER FIVE

5.0 RESULT AND DISCUSSION

5.1 Socio Economic Characteristics of Respondents

5.1.1 Gender

The result shows that majority (64%) of the fish processors using modified drum oven technology were male, while 36% of the respondents were female. The result for fish processors using traditional technology revealed that majority (61) were female, while 39% were male (Table 2). The fact that more women are involved in traditional fish processing technology than men could be attributed to the type of technology been used in the area (mud oven). The study showed that more men were into modified drum oven fish processing technology than women; these could be credited to the fact that agricultural production and processing is faced with a lot of risk and uncertainties and most women are risk averse. The study agrees with Nwachukwu and Onuegbu, (2007); Fregene and Amure, (2013); Olaoye and Oloruntoba (2010); Salau *et al.* (2014) who found out that more men were involved in aquaculture activities than women. This was contrary to Nwabuaeze and Nwabuaeze, (2011); Udong *et al.* (2009); Kolawole *et al.*(2010) that women dominate the fish processing and marketing in Nigeria.

Table 2: Distribution of fish processors by gender

Gender	Modified Drum Oven Technology		Traditional Technology		All Technologies	
	Freq.	%	Freq.	%	Freq.	%
Male	105	64.0	60	38.5	165	51.6
Female	59	36.0	96	61.5	155	48.4
Total	**164**	**100**	**156**	**100**	**320**	**100**

5.1.2Marital status

The result of the analysis revealed that most of the fish processors using modified drum oven (87%) were married, while 7% were single, the remaining 6% were divorced. Many (72%) of the traditional fish processors were also married, 24% were single while 4% were divorced (table 3). The pooled result shows that majority (80%) of the respondents were married. The high percentage of married respondents could be as a result of the significance given to marriage in the society or culture of the people which encourages early marriage. Most of the respondents have responsibilities to their families. These responsibilities would likely make them willing to seek innovations so as to increase their income earning capacity and improve their standard of living (Raufu *et al.,* 2009).

Table 3: Distribution of fish processors based on marital status

Marital Status	Modified Drum Oven Technology		Traditional Technology		All Technologies	
	Freq.	%	Freq.	%	Freq.	%
Married	142	86.6	113	72.4	255	79.7
Single	12	7.3	37	23.7	49	15.3
Divorced	10	6.1	6	3.9	16	5.0
Total	**164**	**100**	**156**	**100**	**320**	**100**

5.1.3 Age

The result revealed that many (49%) of modified drum oven fish processors are between 40 – 49 years of age. Thirty percent (30%) are between 30 -39 years of age. While 50% of the traditional fish processors fall between 40-49 years of age and 30% are between 30 -39 years (table 4). The mean age of the respondents was 40 years, which shows that both the modified drum oven and traditional fish processors are young and are within the economically active age. The study agrees with the finding of Okunlola, (2010); Agbamu (2006) who posited that younger farmers are likely to accept innovations faster than those who are older and who are not ready to take risk.

Table 4: Age distribution of fish processors

Age	Modified Drum Oven Technology Freq.	%	Traditional Technology Freq.	%	All Technologies Freq.	%
20-29	24	14.6	20	12.8	44	13.8
30-39	50	30.5	47	30.2	97	30.3
40-49	81	49.4	79	50.6	160	50.0
50-59	9	5.5	10	6.4	19	5.9
Total	164	100	156	100	320	100
Minimum=20	Maximum=50	Mean=39.8				

5.1.4 Educational level

Most of the modified drum oven fish processors (88%) have one form of formal education or the other while about 19% have no formal education. The result for traditional fish processors revealed also that 68% had one form of education or the other (Table 5). This indicates that most of the respondents have formal education with 26% of the respondents having Koranic education, 22% secondary education, 13% primary education, while tertiary education and Adult education had 11% and 5% respectively. Education creates a positive rational approach for the acceptance of new ideas and practices. The findings agrees with Akpoko (2001); Farinde *et al.*,(2005); Setotav and Cavillier (2006) affirmed that education is crucial for easy understanding of improved methods of agricultural production. The implication of this result is that majority of the respondents have the propensity to adopt fish processing technologies.

Table 5: Distribution of fish processed based on educational status

	Modified Drum Oven Technology		Traditional Technology		All Technologies	
Education	Freq.	%	Freq.	%	Freq.	%
No formal Education	19	11.6	50	32.2	69	21.5
Adult	10	6.1	8	5.1	18	5.6
Koranic	32	19.5	52	33.3	84	26.3
Primary	23	14.0	20	12.8	43	13.4
Secondary	52	31.7	18	11.5	70	21.9
Tertiary	28	17.1	8	5.1	36	11.3
Total	**164**	**100**	**156**	**100**	**320**	**100**

5.1.5 Household size

Analysis of household size of fish processors using modified drum oven technology indicated that 79% of the respondents had between 1 – 10 members, while 21% of them had more than 11 members (table 6). Fish processors using traditional fish processing technology showed that majority household size (84%) had between 1 – 10 members. The minimum house hold size was 1 and the maximum was 18 with a mean of 7 persons indicating that the respondents had small household size. Large household size is believed to assist in the supply of farm labour but the study revealed otherwise.

Table 6: Distribution of fish processors based on household size

	Modified Drum Oven Technology		Traditional Technology		All Technology	
Household Size	Freq.	%	Freq.	%	Freq.	%
1-5	61	37.2	81	51.9	142	44.4
6-10	68	41.5	50	32.1	118	36.9
11-15	27	16.5	20	12.8	47	14.7
16-20	8	4.8	5	3.2	13	3.6
Total	164	100	156	100	320	100
Minimum=1	Maximum=18	Mean=6.9				

5.1.6 Family members involved in fish processing

The study revealed that most (66%) of the modified drum oven fish processors had between 1 – 3 family members involved in fish processing, while about 30% had more than 4 family members in fish processing, in contrast, for processors using traditional technology 90% had 1-3 family members in fish processing and 9% had 4-6 family members in fish processing (table 7). The pooled result shows that 78% of the processors had 1-3 family members in fish processing while about 20% had 4-6 members in fish processing. The mean score of family members involved in fish processing was about 3 members, meaning that there are more family members involved in fish processing in the study area.

Table 7: Distribution of fish processors based on number of family members involved in fish processing

	Modified Drum Oven Technology		Traditional Technology		All Technology	
Family Members	Freq.	%	Freq.	%	Freq.	%
1 – 3	108	65.9	140	89.7	248	77.5
4 – 6	49	29.9	14	9.0	63	19.7
7 – 9	7	4.2	2	1.3	9	2.8
Total	164	100	156	100	320	100
Minimum=1	Maximum=8	Mean=2.8				

5.1.7 Years of experience

Twenty eight percent (28%) of the fish processors (modified drum oven and traditional technology) had between 16 – 20 years of experience each, while 12% and 14% of the respondents had less than 5 years of fish processing experience respectively. About 12% and 18% of the respondents had 11-15 years of experience in that order (table 8). All the technology result showed that 28% of the fish processors had 16- 20 years experience while 13% had less than 5 years experience. The minimum years of experience of the respondents were 1 while the maximum was 25 years. The mean years of experience were 6 years. This implies that fish processors in the study area are relatively new in fish processing.

Table 8: Distribution of respondents based on fish processing experience

	Modified drum oven Technology		Traditional technology		All processing Technology	
Processing Experience	Freq.	%	Freq.	%	Freq.	%
1-5	20	12.2	22	14.1	42	13.1
6-10	45	27.4	24	15.4	69	21.6
11-15	20	12.2	37	23.7	57	17.8
16-20	46	28.1	43	27.6	89	27.8
21-25	33	20.1	30	19.2	63	19.7
Total	164	100	156	100	320	100
Minimum=1	Maximum=25	Mean=14.0				

5.1.8 Extension contact

The result in table 9 shows that 89% of the respondents who adopted modified drum oven had no contact with extension workers, while 11% had extension contact indicating that majority had no extension contact. The inadequate and ineffective extension delivery system may be the reason why majority had no extension contact but got information about the modified drum oven technology from radio and television (40%) as shown in table 22.

Table 9: Distribution of fish processors by extension contact

	Modified Drum Oven Technology		Traditional Technology		All Technology	
Extension Contact	Freq.	%	Freq.	%	Freq.	%
Contact	18	11.0	106	68.0	124	38.8
No Contact	146	89.0	50	32.0	196	61.2
Total	**164**	**100**	**156**	**100**	**320**	**100**

5.1.9 Number of extension contact

Majority (86%) of the fish processors using modified drum oven technology had extension contacts of 1 – 3. While about 20% of the respondents had extension contact of 4 – 6 contacts. Majority of the traditional fish processors had 1-3 contacts (table 10). The polled result shows that of the 196 fish processors; 172 (88%) had between 1-3 contacts whereas 24(12%) had 4-6 contacts. The implication of this result is that even though most of the processors had extension contact, the number of contacts needs to be increased for them to get the benefits of extension delivery services. The minimum contact was 1, while the maximum contact was 8. The mean was 2 indicating that most of the fish processors had few contact from extension agents.

Table 10: Distribution of fish processors based on number of extension contacts

	Modified Drum Oven Technology		Traditional Technology		All Technologies (n=196)	
No of Ext. Contact	Freq.	%	Freq.	%	Freq.	%
1-3	126	86.3	46	92	172	87.8
4-6	20	13.7	4	8	24	12.2
7-9	-	-	-		-	-
Total	146	100	50	100	196	100
Minimum=1	Maximum=8	Mean=2.4				

5.1.10 Membership of cooperatives

Majority (82%) of the fish processors using modified drum oven technology belong to cooperatives, while 18% does not belong to cooperative organization (table 11). Most (72%) of the fish processor that use traditional technologies do not belong to cooperative organizations only 28% belong to a cooperative organizations. the polled result showed that 56% belong to cooperative organization while 44% does not belong to any organization. Membership of cooperative has been found to influence adoption of improved technologies and this is in line with Ekpe and Obeten, (2004); Mijindadi and Njoku (1985) where they found statistically significant association between membership of association and adoption of innovations.

Table 11: Distribution of fish processors based on membership of cooperative

Membership of cooperative	Modified Drum Oven Technology		Traditional Technology		All Technologies	
	Freq.	%	Freq.	%	Freq.	%
Member	134	81.7	44	28.2	178	55.6
Non Member	30	18.3	112	71.8	142	44.4
Total	**164**	**100**	**156**	**100**	**320**	**100**

5.1.11 Years of membership

The study revealed that about 49% of the fish processors using modified drum oven are members of cooperative organization but have spent less than a year as members of the organization. About 42% of the respondents (modified drum oven technology) had between 1-5 years membership of cooperative (table 12). Majority (77%) of the fish processors using traditional technology have spent less than a year. While about 18% had between 1-5 years. This indicates that majority (56%) are new members of cooperative organization as shown from the poll data, implying that the most of the fish processors are new in the cooperative organizations.

Table 12: Distribution of fish processors based on years of membership of cooperative

Years of Membership	Modified Drum Oven Technology Freq.	%	Traditional Technology Freq.	%	All Technologies Freq.	%
< 1	65	48.5	34	77.3	99	55.6
1-5	56	41.8	8	18.2	64	36.0
6-10	5	3.7	2	4.5	7	3.9
11-15	6	4.5	-	-	6	3.4
16-20	2	1.5	-	-	2	1.1
Total	134	100	44	100	178	100
Minimum=**1**	Maximum=18	Mean=1.4				

5.1.12 Reason for non-membership

The results show that of the fish processors that do not belong to a cooperative society (142) about 42% reported that they were not aware, while 12% were not interested in joining the cooperatives (Table 13). Twenty five percent (25%) indicated that cooperative organizations were not established in the study area. This could be the reason why most of the respondents in table 9 are new members of cooperatives in the study area. Most cooperative organizations are deeply involved in activities that will impact on the livelihood of members.

Table 13: Distribution of fish processors based on reasons for non-membership of cooperative

Reason non membership of cooperative	Frequency (n=142)	Percentage
Not aware	60	42.3
Not established	35	24.6
Not interested	18	12.7
Not functional	29	20.4
Total	**142**	**100.0**

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5.1.13 Benefits derived from joining cooperatives

Majority (68%) of the fish processors using modified drum oven that joined the cooperative organizations are yet to benefit from the organization, while 32% of them have been able to access loan as shown in table 14. This shows that those members that have not benefited from joining the cooperatives are yet to benefit owning to the fact that they joined recently not up to a year (table 13). Fish processors using traditional technology indicated that they were yet to benefit (51%) from belonging to a cooperative organization, while 49% benefited inone way or the other as shown below (table 15). This is in line with Ekpe and Obeten (2004), who stated that farmers who are members of cooperative societies are usually better informed on innovations and obtain technical inputs more easily than those who are not members. The fundamental objective of any agricultural cooperative is to increase production and credit facilities to members.

Table 14: Distribution of fish processors based on benefits derived from joining cooperative

Benefits derived	Modified Drum Oven Technology		Traditional Technology		All Technologies (n=178)	
	Freq.	%	Freq.	%	Freq.	%
Yet to benefit	77	68.1	33	50.8	110	61.8
Bought motorcycle	6	5.3	5	7.7	11	6.2
Purchased electronic	6	5.3	2	3.0	8	4.5
Access to loan	6	5.3	10	15.4	16	9.0
Contributions	13	11.5	6	9.2	19	10.7
Expanding business	3	2.7	4	6.2	7	3.9
Information	2	1.8	5	7.7	7	3.9
Total	**113**	**100**	**65**	**100**	**178**	**100**

5.1.14 Access to credit

Most, 55% of the fish processors who adopted modified drum oven indicated that they had no access to credit, while 22% of the respondents using traditional technology had access to credit (table 15). This implies that access to credit is a problem to fish processors in the study area as indicated by the fish processors that did not have access to credit (66%) in the polled data.

Table 15: Distribution of fish processors based on access to credit

	Modified Drum Oven Technology		Traditional Technology		All Technologies	
Access to credit	Freq.	%	Freq.	%	Freq.	%
Accessible	74	45.1	34	21.8	108	33.7
Not Accessible	90	54.9	122	78.2	212	66.3
Total	**164**	**100**	**156**	**100**	**320**	**100**

5.1.15 Sources of credit

About 24% of the fish processors using modified drum oven access credit from friends and relatives, while 22% access credit from friends and relatives (table 16). Implying that about (25%) of fish processors sourced credit from their friends and relatives. Credit is vital to any successful enterprise and when there is no access to credit the fish processors will process at subsistence level. The study is in line with Teklewold *et al*. (2006) where they found that availability of credit is one of the most important determinants of smallholder farmers' adoption.

Table 16: Distribution of fish processors according to sources of credit in the study area

Source of credit	Modified Drum Oven Technology		Traditional Technology		All Technologies	
	Freq.	%	Freq.	%	Freq.	%
Banks	14	8.4	7	3.9	21	6.6
Friends and relatives	40	24.1	39	21.7	79	24.7
Cooperatives	21	12.7	12	6.7	33	10.3
NGO	1	0.6	-	-	1	0.6
					*346	

*****Multiple Response Allowed

5.1.16 Amount of credit obtained

The study revealed that about (46%) of the respondents using modified drum oven obtained credit of between ₦101, 000 – 200, 999 for their fish processing business. While 32% of the respondents obtained less than ₦ 100, 999 for their processing activities (Table 17). The maximum amount of credit obtained by fish processors was ₦250, 000. The mean amount obtained by the respondents was ₦33, 956.79. Credit is an important factor influencing adoption of fish processing technologies; the result indicated that most of the respondents had to operate their businesses from other sources of credit (Table 16).

Table 17: Distribution of fish processors based on amount of credit obtained

Amount of credit(₦)	Frequency(n=108)	Percentage
<100, 999	34	31.5
101, 000 – 200, 999	50	46.3
200, 999 – 300,999	24	22.2
Total	**108**	**100.0**
Minimum = 0	Maximum = 250, 000	Mean = 33, 956.79

5.2 Factors Influencing Adoption of Modified Drum Oven Fish Processing Technology

Several factors were responsible for using the modified oven drum fish processing technology by the respondents. Some of the factors obtained include; socioeconomic factors such as age, sex, marital status, household size, extension contact, income, and experience in fish processing, quantity of fish processed compatibility, affordability and complexity of processing equipment. The result of the logit regression on the socio economic characteristics of the fish processors and adoption of modified drum oven fish processing technology is shown in Table 18. The result revealed that, all the explanatory variables such as age, sex, marital status, extension contact, income, experience in fish processing, level of education, household size, membership of cooperative, compatibility, affordability and quantity of fish processed have the expected positive signs. Access to credit (-0.769) and complexity (-4.081) have negative coefficients meaning that as access to credit and complexity increases by one unit, adoption decreases by the corresponding coefficient. Complexity is negative but significant at 1% probability level. With the exception of marital status, level of education, household size, extension contact,

membership of cooperative, access to credit and affordability which are not significant, the estimated coefficients for parameters like, age (0.047), experience in fish processing (0.048) and compatibility (0.412) which are significant at 5% probability level, sex (3.448), income (2.256) and processed fish output (2.385) were significant at 1% probability level. The findings of this study agrees with Kolawole (2001), where age, family size, religion, education, farm size, association membership, farming scope, and income level were significant factors to the use of Indigenous knowledge systems for soil fertility conservation. Also the result of this study conforms to the findings by Mercy and Oludare (2015) in their study of determinants of use of indigenous fish processing practices in maritime and inland states of Nigeria; they posited that there was significant relationship between the socioeconomic characteristics and indigenous fish processing practices used in the study area. Age being positive and significant contributes to the adoption of the modified drum oven fish processing technology in the study area. That is, older processors may not use tedious practices because of weakness and would therefore adopt a technology that would reduce their drudgery. Education also affects the adoption of technology since the well-educated is expected not to use traditional means of processing.

5.2.1 Test of hypothesis i: The hypothesis which stated that factors influencing adoption of modified drum oven fish processing technology have no significant impact on fish processors income was also tested and the result revealed that age (0.047), experience in fish processing (0.048) and compatibility (0.412) were significant at 5% probability level, while sex (3.448), income (2.256) and processed fish output (2.385) and complexity (-4.081) were significant at 1% probability level. The R square value (58.762) which is significant at 1% probability level implies that 59% of the decision to adopt modified drum

oven fish processing technology was explained by the independent variables. The significance of these variables indicates that these factors are required for consideration in the formulation of fish processing technologies-use strategies in the study area. Therefore the null hypothesis which states that factors influencing adoption of modified drum oven fish processing technology have no significant impact on fish processors income was rejected and the alternative accepted.

Table 18: Logit regression results showing factors influencing the adoption of modified drum oven fish processing technology

Parameter	**Regression Coefficient**	**Standard Error**	**t-value**
Intercept	-2.756		
Age	0.047	0.022	2.104**
Sex	3.448	0.837	4.163***
Marital Status	0.470	0.326	1.440
Level of education	0.856	0.563	-1.519
Household size	0.003	0.035	-0.108
Extension contact	0.120	0.337	0.356
Income	2.256	0.195	11.582***
Experience in fish processing	0.048	0.026	1.843**
Membership of cooperative	0.041	0.061	0.699
Access to credit	-0.769	0.831	-0.925
Processed output of fish	2.385	0.183	13.009***
Compatibility	0.412	0.174	2.362**
Complexity	-4.081	0.566	-7.216***
Affordability	1.827	0.520	3.584
R-square	58.762***		

*** P<0.01, ** P<0.05

5.3 Processing Activities in the Study Area

5.3.1 Source of fish processed

Over 67% of fish processors that adopted modified drum oven purchased their fish, while 17% of the respondents captured and harvested their fish. Forty five (45%) percent of traditional fish processors purchased their fish for processing, while captured and harvested accounted for 30% and 25% respectively (table 19).

Table 19: Distribution of fish processors based on source of fish processed

	Modified Drum Oven Technology		Traditional Technology		All Technologies	
Source of fish processed	Freq.	%	Freq.	%	Freq.	%
Purchased	117	66.5	93	45.0	210	54.8
Captured	29	16.5	63	30.4	92	24.0
Harvested	30	17.0	51	24.6	81	21.2
Total	**176**	**100**	**207**	**100**	***383**	

*Multiple responses were allowed

5.3.2Source of labour

Fifty eight percent (58%) of the fish processors sourced their labour from family members. About 28% sourced from both family and hired labour, while 15% use hired labour (table 20). This indicates that more of the respondents use family labour which can be attributed to the fact that because they are family members they were not paid wages but rather tokens were given after sale.

Table 20: Distribution of fish processors based on source of labour for fish processing

	Modified Drum Oven Technology		Traditional Technology		All Technologies	
Labour source	Freq.	%	Freq.	%	Freq.	%
Family	98	59.8	86	55.1	184	57.5
Hired	20	12.2	28	17.9	48	15
Both family and hired	46	28.0	42	27.0	88	27.5
Total	**164**	**100**	**156**	**100**	**320**	**100**

5.3.3Average quantity of fish processed

Majority (85%) of the respondents who adopted modified drum oven processed an average of 1 – 50 kilograms of fish daily; while 13% of the fish processors process 51 -200 fish (table 21). Most (94%) of the fish processors using the traditional technology process an average of 51-100. While only 6% of the respondents processed 51-100. The result sowed that a minimum of 17 fish is processed daily, while a maximum of 181 fish is processed daily. The mean average fish processed in the study area is 32%. This indicates that most (89%) of the fish processors process an average of between 1 – 50kg of fish daily.

Table 21: Distribution based on fish processor's average quantity of fish processed daily

Average Quantity of fish processed (per day)	Modified Drum Oven Technology Freq.	%	Traditional Technology Freq.	%	All Technologies Freq.	%
1-50	139	84.8	146	93.6	285	89.1
51-100	21	12.8	10	6.4	31	9.7
101-150	2	1.2	-	-	2	0.6
151-200	2	1.2	-	-	2	0.6
Total	164	100	156	100	320	100
Minimum=17	Maximum=181	Mean=31.56				

5.3.4Source of information for modified drum oven technology

Forty percent (40%) of the respondents got information on modified drum oven fish processing technologies through radio and television while 29% got information on the fish processing technologies from research institute. It was followed by fellow fish processors with 10%, Federal department of fisheries 8%, and ministry of agriculture 7%. Those fish processors who got information from village extension agent, research bulletins and Non Governmental Organizations were 3%, 2% and 2% respectively (table 22). The result implies that most (40%) of the fish processors got information on the technologies from radio and television. Proximity to the NIFFR could be attributed to why twenty nine percent got information from research institutes. Contrary to Njoku (1990) that agric extension agents serve as main source of information to farmers, the study showed that a few (3%) got information from extension agents.

Table 22: Sources of information on modified drum oven fish processing technology

Source of Information	Frequency (n=164)	Percentage
Village Extension Agent	5	3.0
Research Institute(s)	47	28.7
Ministry of Agric.	12	7.3
Fed. Department of Fisheries	11	6.7
Radio and Television	65	39.6
Fellow Fish Processors	17	10.4
Bulletins and Newsletter	4	2.4
NGO	3	1.8
Total	**164**	**100**

*Multiple responses were allowed

5.3.5Attributes of modified drum oven technology

The distribution of fish processors according to attributes (complexity) of the modified drum oven technology show that majority (88%) of the fish processors found the technology to be simple to adopt (table 23). In terms of affordability, over 67% reported that modified drum oven was cheap in terms of cost. While 10% explained that the technology was expensive to adopt. The modified drum oven fish processing technologies was reported to be very compatible by 74% of the respondents, while about 4% reported that modified drum oven fish processing technology was not compatible. These finding is

in line with Bembridge, 1991; Vanclay, 1992; Ogunbameru, 2001 who indicated that cost, complexity, compatibility, has been identified as factors influencing the adoption process.

Table 23: Distribution respondents according to attributes of modified drum oven fish processing technology

Attributes of Modified Drum Oven	Frequency (n=164)	Percentage
a). Complexity		
Simple	145	88.4
Complex	17	10.4
Very complex	2	1.2
Total	164	100
b). Affordability		
Cheap	110	67.1
Moderate	37	22.6
Expensive	17	10.3
Total	164	100
c). Compatibility		
Not compatible	6	3.7
Compatible	37	22.6
Very compatible	121	73.7
Total	**164**	**100**

5.4 The Impact of Adoption of Modified Drum OvenFish Processing Technologies on Income of Fish Processors in Niger State

The result of the Z test as presented in table 24shows that the calculated Z value (2665.17) is greater than the table Z value of 1.64 at one tail and 1.96 at two tails respectively and it is significant at 1% probability level. This implies that there is significant difference between the income of respondents who adopted modified drum oven fish processing technology and those who did not adopt the technology.

The result of the Z statistic clearly shows that the difference between the annual income of the fish processors that adopted modified drum oven fish processing technology and those who did not adopt is significant thereby implying that adoption of modified drum oven fish processing technology had an impact on the income of the fish processors that adopted fish processing technologies which contributed in enhancing the income of the fish processors in the study area. This finding is in consonance with Robert and Noma-Fame (2012) who found out that average income of adopters of fish processing technologies in Ghana (GHC 8,204.50) which is higher than income of non-adopters (GHC 3,134) of fish processing technologies. Also Ndjuenga*et al.*(2008) found out that the average income from adopters ($204/ha) of modern groundnut varieties in Nigeria was estimated to be significantly higher by $123/ha for non-adopters in a study of early adoption of modern groundnut varieties in West Africa. Also, Kassie *et al*. (2010) posited that adopters of groundnut technology seemed to be better off than non-adopters as the average annual total household income per capita was UGX 522,284 (US$ 282) and UGX 476,148($257) for adopters and non-adopters, respectively in a study on Adoption and impact of improved groundnut varieties on rural poverty in

Uganda. From the result of the frequency distribution of the annual income of adopters and non-adopters of modified drum oven fish processing technology in Niger state (Tables 25) 26%of the fish processors that adopted the technology fall within the highest annual income range of above ₦599, 000 while in the case of the non-adopters of modified drum ovenfish processing technology, only 16% fall within the highest annual income range of above ₦ 599,000. Thirty four (34) percent of the adopters of modified drum oven fish processing technology are within the lowest annual income range of ₦ 100, 000 - ₦ 199, 000 as opposed to 47% of the non-adopters of the technology. The mean annual income of fish processors that adopted modified drum oven (₦382,813.00) is higher than the mean annual income of non-adopters (₦201,723.40) which implies that the adopters of modified drum oven fish processing technology realized higher income than the non-adopters in the study area.

The table also revealed that the standard deviation of the income of the fish processors that adopted modified drum oven was (₦ 412,310.40) and is higher than that of fish processors that did not adopt modified drum oven(₦ 210,310) which imply that there is a higher variability in the income of adopters than that of the non-adopters. This result is in conformity with the findings by George *et al.* (2014) in a study of fish processing technologies in Nigeria.

Table 24: Frequency distribution of the annual income of modified drum oven and traditional fish processing technologies in Niger State

Variable	MDOT		Traditional	
	Frequency	**Percentage**	**Frequency**	**Percentage**
100,000 -199,000	34	20.7	47.00	30.1
200,000 -299,000	33	20.2	37.00	23.7
300,000 - 399,000	29	17.7	22.00	14.1
400,000 - 499,000	18	10.9	20.00	12.8
500,000 – 599,000	24	14.6	14.00	9.0
> 599,000	26	15.9	16.00	10.3.
Total	164	100.0	156.00	100.0
Minimum	181500		142,150.00	
Maximum	1621715		1,315,201.00	
Mean	382813		201,723.40	
Standard deviation	412310.04		210,310.00	

5.4.1 Statistical comparison of income of modified drum oven and traditional fish processing technologies in Niger State

Test of hypothesis ii: the hypothesis which stated that adoption ofmodified drum oven fish processing technology has no significant impact on fish processors income was tested using z test. The calculated z value (2665.17) is greater than the table z value of 1.64 at one tail and 1.96 at two-tail respectively as shown in Table 25 and it is significant at 1% probability level. The result implies that there is a significant difference between the

income of fish processors who adopted modified drum oven fish processing technology and those that did not adopt the technology and therefore, the null hypothesis is rejected and the alternative accepted. This suggests that modified drum oven fish processing technology has contributed in enhancing the income of the adopters of the technology and therefore, non-adopters of the technology can increase their income level through adoption of the technology.

Table 25: Comparison between the income of modified drum oven and traditionalfish processing technologies in Niger State

Variable	Modified drum Oven Technology	Traditional Technology
Mean	252156.25	148416.10
Known variance	127783	106753.6
Observation	164	156
Hypothesized mean difference	0.00	
Z	2665.17	
P(Z<=z) one-tail	0.00	
Z Critical one-tail	1.64	
P(Z<=z) two-tail	0.00	
Z Critical two-tail	1.96***	

*** P<0.01

5.5 Comparison between the Level of Living of Modified Drum Oven Technology and Traditional Fish Processing Technologies in Niger state, Nigeria

Test of hypothesis iii:which states that adoption of modified drum oven fish processing technology has no significant impact on fish processors level of living, z test was carried out.The result of the analysis of the level of living between adopters and non- adopters of the technology (level of living was estimate based on the value of assets owned by the respondents) in the study area shows that the mean value of assets owned by adopters was ₦ 3,469,441.46 as against ₦ 3,016,632.72 owned by the non- adopters of modified drum oven technology, the mean income differential between the two groups was ₦103, 740.14. The Z test as presented in Table 26 shows that the calculated z value (945.29) is greater than the table z value of 1.96 at two tails and it is significant at 1% probability level. This implies that there is a significant difference in the level of living of adopters and non-adopters of modified drum oven fish processing technology in the study area. Therefore, the adoption of the technology has contributed in uplifting the level of living of the adopters of modified drum oven fish processing technology in the study area and therefore the null hypothesis was rejected and the alternate accepted.

Table 26: Result of statistical comparison between the level living of adopters and non-adopters ofmodified drum oven fish processing technology in Niger state.

Variables	Modified Drum Oven Technology	Traditional Technology
Mean value of assets owned	3469441.46	3016 632.72
Standard deviation	20082686	16692227.71
Observations	164	156
Mean income Differential	103740.14	
Z calculated	945.29***	
Z critical two-tail	1.96	

***** P<0.01**

5.6 Constraints Inhibiting Adoption of Fish Processing Technologies in Niger State

5.6.1 Traditional fish processing methods

The study revealed that most (34%) of the respondents revealed that it took longer time to process fish using the traditional methods and it ranked first (table 27). It was followed by short life span after processing with 25% (2). The third constraint of traditional technology was poor quality of product with 20% while high fuel/firewood consumption, low batch capacity, and high construction cost were ranked 4 (10%), 5 (6%) and 6 (5%) respectively. This shows that traditional fish processing technology is characterized by time-consuming in terms of processing, short life span and poor product quality.

Table 27: Distribution of respondents based on problems encountered in traditional fish processing technology

Problems	Frequency	Percentage	Rank
Poor quality of product	56	19.9	3
Low batch capacity	18	6.4	5
High fuel consumption	29	10.3	4
Takes longer time to process	94	33.5	1
Short life span after processing	70	24.9	2
High construction cost	14	5.0	6
	*281		

NB: *Multiple responses were allowed

5.6.2 Modified drum oven fish processing technology

The result of the analysis of constraints faced by the fish processors (table 28) show that inadequate capital ranked highest (1st) with 41% followed by high cost of purchasing fish processing equipment with 25%. Training ranked 3rd with 16% and the fourth is extension contact with 10% and the fifth is high fuel consumption with 7%. This indicate that inadequate capital, high cost of purchasing fish processing equipment and training as the major constraint in the study area.

Table 28: Distribution of respondents according to constraints of modified drum oven fish processing technology

Constraint	**Frequency**	**Percentages**	**Rank**
Inadequate capital	87	41.2	1
Training	53	25.1	2
Extension Contact	34	16.1	3
Market	22	10.4	4
High fuel consumption	15	7.1	5
	*211		

NB: Multiple responses were allowed

CHAPTER SIX

6.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary

This study was conducted to analyse the Impact of Adoption of Modified Drum Oven Technology on income and Level of Living of Fish Processors in Niger State, Nigeria. The specific objective was todescribe the socio-economic characteristics of the fish processors in the study area, determine the factors influencing adoption of modified drum oven fish processing technologies, determine the impact of adoption of modified drum oven fish processing technology on fish processors income, determine the impact of adoption of modified drum oven fish processing technology on fish processors level of living and identify constraints inhibiting the adoption of the recommended fish processing technologies.

Multi-stage sampling technique was adopted for this study. The first stage involved the purposive selection of all the Eight (8) Local Government Areas where fishing and fish processing activities are practiced and two villages from each of the eight (8) LGAs were selected because of the prevalence of fish processing activities making a total of 16 villages. The third stage was the random selection of twenty (20) respondents from each village. At the end a total of 320 fish processors were selected. The fish processors were further segregated into two groups of adopters of modified drum oven fish processing technology (164) and non-adopters who used traditional fish processing technology (156).

The study revealed that majority (52%) of the fish processors were male indicating more men were involved in the processing of fish. Over 80% of the respondents are married.

About 50% of the fish processors fall between 40 -49 years of age with a mean age of 34 years which indicates that younger people were involved in fish processing. Majority (79%) of the fish processors had one form of formal education or the other. The mean for family members involved in fish processing is 3 members. Over 56% of the fish processors belong to cooperative organizations. Majority (64%) of the fish processors that joined the cooperative were yet to benefit from the organization meaning that they were relatively new in joining these cooperative organizations. Most (66%) of the fish processors had no access to credit. Processing activities in the study area show that over 66% of fish processed were purchased by the fish processors from the market. The mean for processed fish daily is 32. Over 76% of the respondents used modified drum oven fish processing technology for processing. The mean annual income of fish processors that adopted modified drum oven fish processing technology (₦382,813.00) was higher than the mean annual income of non-adopters (₦201,723.40) in the study area.

The logit regression model result revealed that with the exception of marital status, level of education, household size, extension contact, membership of cooperative, access to credit and affordability which are not significant, the estimated coefficients for parameters like, age (0.047), experience in fish processing (0.048) and compatibility (0.412) which are significant at 5% probability level, sex (3.448), income (2.256) and processed fish output (2.385) were significant at 1% probability level implying that these factors have significant influence on adoption of modified drum oven fish processing technology. The R^2value (58.762) which is significant at 1% probability level implies that 59% of the decision to adopt modified drum oven fish processing technology was explained by the independent variables.

The study revealed that the major constraints for fish processors using the traditional fish processing technology to be; it takes longertime to process ranked 1st (74%), short life span ranked 2nd (50%) and poor quality of product ranked 3rd (49%). The foremost constraint inhibiting the adoption of improved fish processing technology were inadequate capital 55%, lack of training 45% and extension contact 36%.

6.1 Conclusion

Going by the empirical evidence emanating from this study, it is generally revealed that majority of fish processors had one form of education or the other. The mean age of the fish processors was 34 years indicating that fish processors in the study area are in their youthful and active age,and many of the respondents had no access to credit as such they sourced from other businesses to support their fish processing activities. Adoption of modified drum oven fish processing technology in the study area was high and adoption of the fish processing technology has significant impact on fish processors income (₦252,156.25) and level of living (₦346,9441.46) in the study area. The foremost constraint inhibiting the adoption of improved fish processing technology were inadequate capital, lack of training and extension contact.

6.2 Recommendations

The recommendation in this study includes;

i. Credit facilities should be made available and accessible to the fish processors by the Government. This could be achieved through enforcement (Central Bank of Nigeria) of agricultural credit delivery by commercial banks and micro finance institution to

fish processors. These also can be achieved through aggressive mass media sensitization on credit accessibility for interested individuals or groups;

ii. Cooperative organization becomes imperative in order to encourage fish processors who source credit from either agricultural or non agricultural source so as to help alleviate their financial problems. These can be achieved through Proper sensitization of fish processors by NGOs and other development agencies on group formation and development and also not just forming groups but they should be functional. These functional fish processing cooperative groups can contribute money to buy or fabricate modified improved technologies for their members;

iii. Training should be organized by research institutes, ADPs, NGOs, and other developmental organizations for fish processors on use of improved fish processing technologies, how to optimize their profits, and also how to expand their fish business e.g. adding value to their products;

iv. Extension delivery service should be funded properly by Government so as to enable their services be enjoyed and reach a number of fish processors which will increase adoption of more improved technologies by interested individuals/fish processors

v. Relevant research institutes (NIFFR, NIOMR) should design improved fish processing technologies that are accessible, user friendly, affordable and also relevant to the fish processors.

6.3 Contribution to Knowledge

The study "Analysis of Factors Influencing the Adoption of Modified Drum Oven Fish Technology and its Impact on Income and Level of Living of Fish Processors in Niger State, Nigeria" reveals that;

i. The difference between the annual income of the fish processors that adopted modified drum ovenfish processing technology and those who did not adopt is significant at 1% probability level thereby implying that adoption of modified drum ovenfish processing technology had an impact on the income of the fish processors that adopted, which contributed in enhancing the income of the fish processors. The mean annual income of fish processors that adopted modified drum ovenfish processing technology (₦382,813.00) is higher than the mean annual income of non-adopters (₦201,723.40) which implies that the adopters realized higher income than the non-adopters in the study area;

ii. The logit regression model result revealed that the coefficient of age (0.047), experience in fish processing (0.048) and compatibility (0.412) which are significant at 5% probability level, sex (3.448), income (2.256), processed fish output (2.385) and complexity (-4.081) were significant at 1% probability level implying that these factors have significant influence on adoption of modified drum oven fish processing technology on fish processors income; and

iii. The Z test showed that the calculated z value (945.29) is greater than the table z value of 1.96 at two tails and it is significant at 1% probability level, implying that there is a significant difference in the level of living of adopters of modified drum oven and those using traditional fish processing technology in the study area.

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APPENDIX 1

Relative poverty: Non-poor, moderate poor and the extremely poor (%), 1980 – 2010

Year	Non Poor	Moderately poor	Extremely Poor
1980	72.8	21.0	6.2
1985	53.7	34.2	12.1
1992	57.3	34.2	12.1
1996	34.4	36.3	29.3
2004	43.3	32.4	22.0
2010	31.0	30.3	38.7

Source: NBS, 2010

APPENDIX 2

Appendix I: Questionnaire

Department of Agricultural Economics and Rural Sociology

Faculty of Agriculture,

Ahmadu Bello University – Zaria

Title: Analysis of Factors influencing adoption of fishery technologies and its impact on income and poverty level of fisher folks in Niger State, Nigeria

Questionnaire No: …….

SECTION A. Socio-Economic Characteristics of Processors

State: ---------- LGA ---------- Villages----------

1. Age: ---------- 2. Gender: Male---------- Female----------

3. Marital status: Single----------Married----------Divorced----------

4. No. of wives: ---------- 5. Religion: ----------

6. Educational Attainment:

   i) No formal education

   ii) Adult education …… years

   iii) Koran……..……years

   iv) Primary……years

   v) Secondary…….years

   vi) Tertiary……..years

   vii) Others(specify)……..…years

7. Household size……

   Adult: Female: …….. Male: ……

   Boys: …….. Girls: ……

8. No of family members involved in processing? ……..

9. How long have you been in fish processing? …… years

10. Do you belong to a group/cooperative society?

Yes ☐ No ☐

11. If yes, give the number of cooperative societies you belong to: ……...

12. If no, give reasons:

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13. Do you have an extension agent in your area?

Yes ☐ No ☐

14. Does the extension agent visit your farm?

Yes ☐ No ☐

15. If yes, how many times have you been visited since January, 2014 Please estimate: ……

16. Do you have access to credit facilities?

Yes ☐ No ☐

17. If yes, state source (s) and amount of credit received from January 2014 till date.

S/No	Source	Amount (₦)

18. If no, how do you finance your fish processing business?

……..

……..

……..

19. Before you went into fish processing what was your source of income?

……..

……

……

20. In your opinion, is there any difference in your income level as a result of joining the cooperative/group/organization?

Yes ☐ No ☐

Section B: Processing Activities

21. Where do you acquire fish for processing? Tick the appropriate

Fishermen ( ) Traders/Middlemen ( ) Cold Stores ( ) Group/ Cooperative Society ( ) others Specify ……

22. What type of fish do you process in your area?

i. …….
ii. …….
iii. …….
iv. ……..
v. ……..

23. What is the source of the fish processed?

i. Captured ( ) ii. Harvested ( ) iii. Purchased ( ) iv. Others Specify( )

24. What average quantity of fish do you process daily? …… (Kg)

25. How long does it take to process these quantities? …….. (Hrs)

26. Do you employ labourers for the work?

Yes ☐ No ☐

27. If No, who assist in the work?

……

28. Reason for Processing

…….

……

29. (a) Tick appropriate processing and preservation methods practiced?

i. Smoking ( ) ii. Drying ( ) iii. Salting ( ) vi. Fermentation( )

v. Icing/ Chilling / Freezing ( ) v. Boiling/ frying ( )

Others specify ……

(b) identify the major type of fish processing technology used in your area?

i. ……..

ii. ……

iii. ……..

Traditional Methods

30. What type of traditional Fish Processing Technology do you use?

i. Mud Oven ( )
ii. Coal Pot ( )
iii. Steel drum ( )
iv. Rack /Raised platform ( )
v. Others Specify ( )

31. What problems do you encounter with these methods? Tick appropriate

a) poor quality of product ( )
b) Low batch Capacity ( )
c) High fuel consumption ( )
d) Takes longer to process ( )
e) Short life span after processing ( )
f) High construction cost ( )
g) Others Specify ( )

Improved fish Processing Technology

32. State which of the following fish technologies you are aware of and first source of information about them:

Technology	**Awareness (yes or no)**	**Source of Information**
a. Modified drum oven b. Choker kiln c. Altona d. Solar tent drier e. Burkinabe		

Sources of information

i. Village Extension Agent (VEA)
ii. Research Institute
iii. Ministry of Agriculture
iv. Non Governmental Organisations
v. Federal Department of Fisheries
vi. Radio
vii. Television
viii. Fellow fish processors/ Friends /Neighbours
ix. News letter
x. Research bulletin
xi. Others Specify

Section C. Adoption of Processing Technologies

33. Technologies adopted and reason:

Technology Adopted (Tick)	**Year**	**Reason for Adoption**
i). Modified drum oven ( )		
ii). Choker Kiln ( )		
iii). Altona ( )		
iv). Solar tent drier ( )		
v). Burkinabe ( )		

Attributes of Processing Technology (tick appropriately)

34. **(a) Complexity**

Technology	Simple	Complex	Very Complex
i). Modified drum oven			
ii). Choker kiln			
iii). Altona			
iv). Solar tent drier			
v). Burkinabe			

(b). Affordability

Technology	Not Affordable	Affordable	Very Affordable
i). Modified drum oven			
i). Choker kiln			
ii). Altona			
iii). Solar tent drier			
iv). Burkinabe			

(c). Compatibility

Technology	Not Compatibility	Compatibility	Very Compatibility
i). Modified drum oven			
ii). Choker kiln			
iii). Altona			
iv). Solar tent drier			
v). Burkinabe			

35. What is your total income from fish processing in the year 2014? …… (Naira)

36. Are you involved in other Agricultural Business?

Yes ☐ No ☐

37. Indicate the total annual income from other agricultural business

S/No	Source(s)	Amount (₦)

38. From the following assets indicate the ones you own.

S/No	Item	Quantity	Current market (₦) value if to be sold	Total value (₦)
a)	Radio			
b)	TV			
c)	Motor-cycle i. Commercial ii. Private			
d)	Bicycle			
e)	Car i. Commercial ii. Private			
iii.	Bus i. Commercial ii. Private			
iv.	Fridge			
v.	House(s) i. Mud ii. Block			
vi.	Cushion/chairs			
vii.	Cattle			
viii.	Sheep			
ix.	Goats			
x.	Poultry			
xi.	Rabbits			
xii.	Pigs			
xiii.	Fish farm			
xiv.	Other(s) specify			

CONSTRAINTS

39. What are the constraints inhibiting the adoption of fisheries technology in the State?

i. ----------
ii. ----------
iii. ----------
iv. ----------
v. ----------
vi. ----------
vii. ----------
viii. ----------

40. Suggest ways to address these constraints:

i. ----------
ii. ----------
iii. ----------
iv. ----------
v. ----------
vi. ----------