ADOPTION OF DROUGHT TOLERANT MAIZE FOR AFRICA (DTMA) AND ITS EFFECTS ON MAIZE FARMERS LIVELIHOOD IN KATSINA STATE, NIGERIA

Ph.D. (Agricultural Extension and Rural Sociology)

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 PHILOSOPHY DEGREE IN AGRICULTURAL EXTENSION AND RURAL SOCIOLOGY

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NOVEMBER, 2015

DECLARATION

I declare that this thesis titled "**Adoption of Drought Tolerant Maize for Africa (DTMA) and its Effects on Maize Farmers Livelihood in Katsina State, Nigeria"** has been written by me and it is a record of my research work. No part of this work has been presented in any previous application for another degree or diploma at any institution. All borrowed information has been duly acknowledged in the text and a list of references provided.

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CERTIFICATION

This thesis titled **"Adoption of Drought Tolerant Maize for Africa (DTMA) and its Effects on Maize Farmers Livelihood in Katsina State, Nigeria"** by Dikko Umaru RADDA meets the regulations governing the award of the degree of doctor of philosophy of the Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This thesis is dedicated to my late father Alhaji Umaru Beriberin Radda and to the Almighty Allah, father of all whose grace has sustained my life and given the enablement to complete this work.

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ABSTRACT

The broad objective of the study was to examine the adoption of Drought Tolerant Maize for Africa (DTMA) and its effects on maize farmers' livelihood in Katsina State of Nigeria. Data for the study were collected through structured questionnaire administered to purposively selected 276 maize farmers using a multi-stage sampling procedure. The data were analyzed using frequencies, percentages, analysis of variance (ANOVA) and multiple regression. The mean experience in DTMA cultivation by the respondents was 8.3 years, with mean farm size of 2.7 hectares of DTMA farm land. Majority (78%) had no access to credit. Also, about 68 percent had no contact with extension agents during the cropping year, while 19 percent belonged to cooperative societies. Respondents perceived that DTMA varieties had high market price as compared with the traditional maize varieties with a mean score of 3.78. The result also shows that respondents with very low yield level (below 1000kg/ha were about 43 percent. Majority (81.8 %) were in the low income group while 10.1 percent were in the high income group. The results showed that 96 percent, 95 percent, 89 percent, and 78 percent of the respondents were aware of Sammaz 18, 22, 24 and Sammaz 23 varieties respectively. Similarly, the DTMA varieties the respondents were least aware of were sammaz 25 (11.3%), Sammaz 27 (13.2%) and Sammaz 26 (15.1%). Majority (81.5%) were in the low level group, while 13.8 percent were in the average socio-economic group, only 4.7 percent were in the high socio-economic group. Thirty seven (37%) mentioned radio as major source of awareness followed by friends and relatives (26%) and extension agents (16%) agro-dealers (8%), television (7%), field days (3%) and demonstration (1%) were the least sources of awareness of DTMA varieties. The result further indicated that 64 percent, 62 percent and 60 percent had adopted Sammaz 18, Sammaz 22 and Sammaz 23 DTMA varieties respectively. The least adopted DTMA varieties were Sammaz 26 (10%), 25 (11.2) and 27 (11.4). On the factors influencing adoption of DTMA varieties findings revealed that farmers' age, household size, education, DTMA farming experience and DTMA farm size were positively and significantly related to adoption. It was also found that extension contact membership to cooperative complexity and relative advantage significantly influenced adoption. It was equally revealed that adoption of DTMA had significant effects on respondents yield, income and level of living. The major constraints affecting farmers in adopting the DTMA varieties were high cost of DTMA, and unavailability of the varieties. The least constraints were: pests and diseases (6.5%), drought (3.3%). High yielding drought tolerant varieties could be massively deployed to drought pronned areas. Irrigation facilities could be made available to supplement inadequate or shortage of rainfall. Unavailability of varieties and high cost of the varieties were major constraint to adoption of DTMA. Seed companies, vendors, distributors, input dealers should be encouraged to site their sales points at the farmers reach to enable farmers purchase needed farm inputs necessary for adoption.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Agricultural production is the mainstay of the Nigerian economy (IPCC, 2001). It is the largest contributor to the livelihood of 75% of the Nigeria's poor who live in rural areas; employs about two thirds of the total labour force. According to Intergovernmental panel on Climate Change (IPCC, 2001) agriculture contributes about 40% of the gross domestic products (GDP) and depends majorly on favourable environmental condition.

Agriculture which is the major occupation and source of livelihood of the rural populace is highly sensitive to environmental variability and weather extremes, such as: droughts, floods and severe storms (Mortimore and Adams, 2001). Due to the enormous uncertainties surrounding agricultural production, cropland reductions especially that of maize vary widely from 10 to 50 percent (Molua, 2000). Intergovernmental Panel on Climate Change (IPCC, 2001) reported that more than 50% of all Sub-Sahara African (SSA) countries assigning over 50% of their cereal area to maize (IPCC, 2001).

As climate change intensifies drought conditions in Africa and sparks fears of a new cycle of crippling food shortages, it is expected that widespread adoption of recently developed drought-tolerant varieties of maize could boost harvests in Nigeria by 10 to 34 percent and generate up to US$1.5 billion in benefits for producers and consumers (Bamire, 2007).

Maize is becoming increasingly important as a food security crop in the dry savanna zones of Nigeria. This crop is most widely grown in the northern guinea savanna, where, with sorghum, is one of the two main cereal crops on 30 to 40% of the cultivated land area (Smith *et al*., 1997).The demand for maize for food, animal and industrial use

is increasing rapidly as population expand across the region. Increasing the productivity of maize-based cropping systems has strategic importance for food security and socio-economic stability of African countries and the sub-region (Bamire, 2007). However, recurring droughts due to change in the climate, provide a continuous challenge to maize production (Bamire, 2007).

The Savanna zone of Nigeria is characterized by a variable weather. The rainfall distribution ranges from a unimodal pattern of the Sudan, Sahel and the Northern Guinea, with annual precipitation of 400 - 600mm to the bimodal pattern of the Southern Guinea with annual rainfall of 1100 - 1400mm (Anor, 1989). The zone has a great potential for food production and is often regarded as the food basket of the Nation. Despite this great potential, the frequent occurence of drought occasioned by erratic rainfall distribution and or cessation of rains during the growing season is the greatest hinderance to" increased production of these food and industrial crops (NARPS, 1996).

Small-scale irrigation, flood recession cultivation and seasonal exploitation of high water-tables in many parts of the savanna have decreased the production of these food crops, majority of the resource-poor farming communities in the savanna still depend on natural rainfall to cultivate their crops. Kamara *et al*. (2006) reported results of studies which showed that annual rainfall in Nigeria during the period 1981-1990 declined from that in 1961-1970 which affected maize output.

The effect of drought is most severe in the dry savanna zones and especially the extreme northern zone where the probability of drought is highest at the start and end of the growing season (Kamara *et al*., 2006). There is the need to move deliberately, but with urgency, to get drought-tolerant varieties from the breeders to the farmers, because their

potential to avert crises is considerable. Adoption of drought tolerant maize production will help reduce the risks of the adverse effects of drought on maize production in Katsina State of Nigeria.

1.2 Problem Statement

Katsina State is characterized by decreasing rainfall pattern and occasional drought which occurs as a result of the varied climatic conditions. In an attempt to address the drought problem on maize, a participatory community survey, targeted at maize production systems that are confronted with drought risks, was conducted in the dry savannas of Nigeria. The main objective of the study was to generate a database for projection of expected outcomes with the deployment of new drought-tolerant maize (DTM) varieties under the drought tolerant maize for Africa (DTMA) project. Maize is an important food security and income-generating crop for millions of people in West and Central Africa (WCA). The DTMA programme is an effort to mitigate the negative impact of drought on maize production and to also improve the dissemination and adoption of relevant improved varieties production technologies to farmers.

Despite the great potential of Katsina State in terms of maize production, the frequent occurence of drought occasioned by erratic rainfall distribution and cessation of rains during maize growing season is the greatest hinderance to increased production of maize (NARPS. 1996). Thus, although the number of households using improved maize seed is fairly high and increasing, the average area planted to drought-tolerant maize varieties is very low, suggesting a low intensity of adoption.

It is clear that government, non-governmental organizations, donor agencies, philanthropies and researchers have given laudable concern in an effort to combat effect of drought on maize production. While these efforts are quite commendable as measures

to increase maize production in general, issues on the mass adoption of the drought-tolerant maize varieties have not been given adequate attention in Katsina State. Moreover attention has only been given on developing drought-tolerant crop varieties without laying emphasis on studying farmers' adoption of the DTMA and its impact on their livelihood. It is with the background on farmers' adoption of these varieties that this study has been designed to answer the following research questions:

i. What are the socio-economic characteristics of maize farmers in the study area?
ii. What is the level of awareness of the available DTMA varieties in the study area?
iii. What is the level of adoption of DTMA by farmers?
iv. What are the factors influencing farmers adoption of DTMA varieties?
v. What are the effects of adoption of the DTMA on farmers' livelihood?
vi. What are the farmers' constraints in the adoption of DTMA varieties?

1.3 Objectives of the Study

The broad objective of the study was to assess the factors affecting adoption of DTMA and its' effects on maize farmers livelihoods in Katsina State of Nigeria.

The specific objectives were to:

i. describe the characteristics of maize farmers' in the study area;
ii. determine the level of awareness of the DTMA varieties in the study area
iii. determine the level of adoption of DTMA by farmers;
iv. determine the factors influencing farmers' adoption of DTMA varieties;
v. determine the effects of adoption of DTMA on farmers' livelihood, and

vi. evaluate farmers' constraints in the adoption of DTMA in the study area.

1.4 Justification of the Study

Concerted efforts have been made in Katsina State to initiate several developmental programmes by both governmental and non-governmental organizations, in spite of the existence of these developmental organizations, the rural areas are still lacking in some of the basic needs and amenities. It is, therefore, not clear whether the introduction of these DTMA maize varieties in the state has any significant contribution to livelihood of its producers in the rural areas of Katsina State or not. However, there is dearth information available in regard to the performance of these DTMA programmes to rural development in terms of the extent of adoption of these programmes to meet up the challenges of food security and rural development in Katsina State, Nigeria. This study intended to investigate the extent of the contribution(s) of these new drought tolerant varieties to the livelihood of its adopters in the study area.

It is an incontrovertible fact that Nigeria's agriculture is still in crisis because only very few of its citizens can be regarded as either food-secured or food self-sufficient. There is thus, an ever increasing concern that despite the huge amount of money invested in breeding maize such as SAMMAZ 18, 20, 33, 23, 24, 25 varieties to meet the challenges of food security, still, this goal is yet to make the desired impact, especially in Katsina State. It is against this background that this study intended to look at the performance of the DTMA varieties and the factors that could limit farmers' adoption of these maize varieties. It is hoped that this study would fill the knowledge gap on the levels adoption of DTMA varieties and how these institutions promoting the adoption of the varieties locally mediate, enable, or support adaptive change, and how rural farmers respond to issues concerning factors militating against adoption of agricultural technologies in the study area.

In addition, this study would provide a basis for gauging how policy changes may affect maize farmers. Policy issues that constrain or enhance the provision of inputs that are required to carry out farm practices have a direct effect on how farmers react to them. The results of this study would provide useful information to enhance the success of the adoption of DTMA production technologies, and indeed any other related program that attempts to introduce practices for adoption in settings that are similar to those in this study area.

It is further expected that the findings of this study would have implications well beyond the confines of the study area and be applied as a national policy development issue. Finally, in Nigeria the DTMA project is also an externally funded project whose continued support is dependent on the effectiveness of the program. Therefore, for continued funding, the DTMA maize varieties introduced must demonstrate benefits to its end users. Yet these benefits do not accrue if farmers do not adopt the practices. A crucial step therefore seems to be to identify the forces that enhance DTMA adoption. This study aims to fulfill this important task.

1.5 Hypotheses of Study

Ho_1. There is no significant relationship characteristics of maize farmers and adoption of DTMA maize production in the study area.

Ho_2. There is no significant effect of the adoption of DTMA maize production and farmers' livelihood in the study area.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Technology Adoption and Farmers' Livelihood

Agriculture is still a major source of employment and income in many developing countries. Improved agricultural technologies therefore, have their greatest impact potentials in developing countries. A range of factors appears to have been critical in determining the rate at which farmers have adopted new ideas and so been able to raise productivity, for the benefit of growth and the pace of poverty reduction. However, in most developing countries, the adoption of improved technological innovations is often constrained by societal dynamic patterns. At the same time, technology adoption affects the distribution of wealth and income in adopting countries (Feder et al., 1985). This has been the case with improved agricultural technologies. Assessing technological impact provides justification for termination, adjustment or further dissemination. This is essential to avoid technological failure and unpleasant benefits on adopters of recommended technologies (Feder et al., 1985).

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 enhanced equity, as it increased returns on assets held by the poor and puts food and cash income directly into the hands of the poor. The smallholder farming sector in developing countries depicts specific characteristics, which must be carefully considered for successful technology transfer. Smallholder farm households derive a substantial share of their livelihood resources from agriculture (even if non-farm income is important) and utilize mainly family labor in the production process.

Smallholder farmers cultivate generally less arable land than national averages. For instance Neil and Lee (2001) revealed that the successful introduction and adoption of maize-mucuna technologies in northern Honduras in the 1970s and 1980s was strongly influenced by its reduction of pre-harvest labor of 15-20% as compared to the traditional system. However, by 1997, external factors such as a (growing market for cattle production), agronomic and biophysical factors (particularly the spread of the itchgrass Rottboellia cochin chinensis on farmers' fields) and management factors (such as failure to reseed mucuna and inappropriate application of herbicides) were jointly responsible for the dis-adoption of maize-mucuna technologies. The technology was dropped at the rate of about 10% per annum in northern Honduras. This example clearly demonstrates how changing external factors can influence production technology. Wetengere (2009) indicated that age, sex, level of education, extension education, land size, income, family size, risk and profitability were positively correlated with the adoption of fish farming technologies in eastern Tanzania (Wetengere, 2009).

Dorward *et al.* (2004) argued that a key feature of many successful early Green Revolution environments was government's role in stabilising output prices, a function which has been progressively dismantled in Africa where innovation has been limited. Wiggins (2000) survey of African case studies found a number of success stories that contradict the general pessimism about African agriculture, but virtually every one was associated with well functioning output markets. In Malawi, Orr and Orr (2002) argued that unreliable maize markets lock many farmers into inefficiently producing as much of their own grain needs as possible, rather than innovating with new crops in which they may well have a comparative advantage.

2.2 Factors Influencing Agricultural Technology Adoption

In general, factors that will influence a farmer's ability and willingness to adopt agricultural technologies involve both farm-specific aspects (i.e. the characteristics of the farmers and the resources at their disposal) and circumstances related to the biophysical and socio-economic context of the farming operation. Technologies may at times be rejected not because of their intrinsic qualities, but rather because they are not compatible with these factors (CIMMYT, 1993).

Information regarding the existence of new agricultural technology is of course a prerequisite for technology adoption. Such information can be obtained from various external sources, such as extension agents, fellow farmers or different media such as television (TV) or radio. Importantly, farmers will also require the necessary information to assess the suitability of the technology for their farming system and to understand the potential risks associated with the use of the technology. For instance, farmers may be uncertain about the profitability of the new technology or differences in economic returns between new and old technologies. Such uncertainties may arise due to insufficient knowledge about yields of new technologies, the types and costs of needed inputs, or expected market prices and demand for the produce (Abadi and Pannell, 1999). Weather conditions and climatic shocks also increase uncertainty and risk, in particular among subsistence farmers who are dependent on rainfall (Abadi and Pannell, 1999).

Another influencing factor in technology adoption is the farmer's attitude to risk. In this context, the farmers' attitude to risk i.e. whether they are risk avert, risk neutral or risk preferring is an important determinant for their willingness to adopt new technologies (Marra and Abadi, 2003). De Silva and Ratnadiwakara (2008) note, however, that

information search costs during the growth stage are influenced by the particular context of Sri Lanka and are likely to be lower in other countries.

A study in Sri Lanka found that the information search costs amounted to around 70% of transaction costs among smallholder farmers (De Silva and Ratnadiwakara, 2008). Searching for information at the decision stage i.e. when deciding which crops to grow, how much land to allocate and how to finance the production was found to incur the second-highest share of information search costs (24%) after search costs incurred during the growth stage (53%). These costs included visits to meet other farmers, arranging loans with finance institutions and renting land from other farmers (De Silva and Ratnadiwakara, 2008).

Information from external sources, such as agricultural extension agents, m-services, radio, TV or newspapers, can play a central role in the assessment of suitability and risk of a technology. A study of maize adoption in Tanzania, for instance, showed that high intensity of extension services was one of the major factors positively influencing the adoption of improved seeds (Abadi and Pannell, 1999). Farmers may also gather information through experimentation ('learning by doing'). Evidence suggests that imperfect knowledge of the technology as a barrier to adoption decreases with experience (Abadi and Pannell 1999; Foster and Rosenzweig, 1995). Alternatively, farmers may also learn from others who are already using the new technology. Foster and Rosenzweig (1995) found that farmers with experienced neighbours were more likely to devote more land to new technologies. Vicinity alone may not be sufficient, however. Rather, farmers appear to learn through more limited social networks that are not based only on geographic proximity (Conley and Udry, 2001).

Access to financial resources and services is another important enabling factor for technology adoption, in particular where financial capital is required to obtain the technologies and associated inputs. Wealthier farmers or those with off-farm income may be more willing to bear the financial risk in case the technology does not perform well (International maize and wheat improvement center CIMMYT, 2009; Marra *et al.,* 2003). Financial resources may also be available through loans. In particular in the case of smallholder farmers, limited access to credit may provide an important constraint to technology adoption as lenders may be unwilling to bear the high transaction costs of small disbursements (Poulton *et al.,* 2006). Also, the seasonality of agriculture and climatic variability can hinder regular repayments. At times, access to credit may also be linked to the use of particular inputs, thus limiting technology choices (CIMMYT, 1993).

Banking facilities offered through bank branches or mobile banking can enable technology adoption by offering transmission services to pay for agricultural technologies or inputs, or to repay loans (Poulton *et al.,* 2006). Famers may also be more willing to adopt new technologies if their financial risks were reduced through insurance schemes to protect against crop failure e.g. due to drought or floods. Insurance schemes for smallholders are subject to similar challenges as credit, however. In particular monitoring and paying out dispersed and small insurance claims can be costly for the insurer (Poulton *et al.,* 2006).

Farmers require the necessary knowledge and information to use technologies. Some studies have found the adoption of new technologies to be positively correlated with the farmer's level of education (Feder *et al*., 1995). This factor is likely to play a more important role the more complex the technology (CIMMYT, 1993). In addition to

schooling, farmers will also benefit from the skills to use the technology that may be acquired in the course of their life through learning (Marra *et al.*, 2003).

As mentioned above, sources of information and learning can encompass external sources including experimentation and learning from others. Moreover, use of the technologies will require additional farm resources, such as labour, machinery, seeds, fertilizer, pesticides, energy, storage facilities and irrigation.

Accessing these resources will need well-functioning labour and input markets which can be a serious constraint in particular in remote areas. Also, where input demand is seasonal and small-scale, there may not be enough incentive to develop the necessary market infrastructure (Poulton *et al.*, 2006). Collective purchasing of inputs, for instance through farmer organizations facilitated by extension services, could help to address these shortcomings by creating economies of scale and reducing transaction costs (Poulton *et al.*, 2006).

According to (Feder *et al*., 1995; Barker *et al.*, 1985) the biophysical and agro-climatic environment can also be crucial for the success of new agricultural technologies, such as soil quality, water availability, topography, seasonal temperature changes or the presence of pests or diseases that could damage the crops. Experience has shown that these environmental factors and in particular the availability of and control over water resources are often the most important factors explaining differences in adoption patterns (Barker *et al.*, 1985).

Measures to manage associated constraints and risks can include the use of agricultural inputs, such as fertilizer, pesticides or irrigation systems (Abadi and Pannell, 1999). Moreover, information related to the production environment can help farmers to adjust their farming practices accordingly. Weather forecasts, for instance, can influence

planting times or water usage while information on soil nutrients or disease outbreaks allows farmers to apply appropriate amounts and types of fertilizers and pesticides.

Rogers (1995) demonstrates that adoption of technologies depends on their characteristics: compatibility with the existing values and norms, complexity, observability, trialability, and relative advantage. This definition pertains to technologies in a variety of disciplines, and may be as relevant in other fields as it is in agricultural related technologies. The significant breakthrough in the development and release of high-yielding extra-early, early, intermediate, and late-maturing varieties with resistance to leaf rust, leaf blight, and leaf spot has caused a phenomenal increase in maize production in WCA, notably in Bénin, Burkina Faso, Cameroon, Chad, The Gambia, Guinea, Ghana, Mali, Nigeria, Senegal, and Togo. Further expansion in production has also occurred in many countries in this subregion because of the adoption of extra-early maturing improved varieties identified from regional trials coordinated by the Semi-Arid Food Grain Research and Development (SAFGRAD) and the West and Central Africa Collaborative Maize Research Network (WECAMAN) (NAERLS, 2009).

The development of extra-early maturing varieties enabled production to expand into new areas, especially to the Sudan savannas where the short rainy season hitherto had precluded maize cultivation. The highest growth in maize area, yield, and production in sub-Saharan Africa since 1961 occurred in WCA. These productivity gains, achieved through farmers' adoption of improved varieties in the 1980s, were driven by the suitability of the cultivars to the major production environments, the availability of inexpensive fertilizer and extension services, as well as favorable government policies that encouraged the use of these technologies (Kaliba *et al.*, 2000).

2.3 Research Institutes Efforts in Technology Development in Nigeria

To promote the establishment of indigenous private seed companies, IITA embarked on the development of hybrids in 1979 with financial support from the Federal Government of Nigeria and the active participation of Nigerian scientists. This led to the release of the first generation of hybrids in 1983, with a spill-over effect of the establishment of seed companies in Nigeria for marketing hybrid maize seeds. The official announcement of IITA's maize open pollinated varieties (OPVs) and hybrids in the catalogs of indigenous seed companies in Nigeria provide further evidence of the adoption, deployment, and commercialization of IITA-bred varieties and hybrids (NAERLS, 2009).

In recent years, IITA has also made significant progress in the development of a large number of maize inbred lines, OPVs and hybrids with resistance to *Striga hermonthica*, stem borers, and aflatoxin contamination, with tolerance to drought, efficient nitrogen use, and enhanced contents of lysine, tryptophan, and pro-vitamin A. The first generation of extra-early, early, intermediate, and late-maturing OPVs and hybrids that combine drought tolerance with resistance to *Striga hermonthica* developed under the Drought Tolerant Maize for Africa Project have been supplied to partners for testing through regional trials. The number of drought-tolerant OPVs identified from these trials and released for production since 2007 were 7 in Bénin Republic, 5 in Ghana, 3 in Mali, and 13 in Nigeria (Kamara *et al*., 2006).

On the other hand, only one drought-tolerant hybrid selected in Mali and six drought-tolerant hybrids selected in Nigeria were released for production. Furthermore, three varieties with high lysine and tryptophan content, two varieties resistant to *Sriga. hermonthica*, two varieties that are nitrogen use efficient, a stem borer-resistant variety, two yellow and two white hybrids were released from 2008 to 2011 in Nigeria

(NAERLS, 2009). To accelerate the release and commercialization of hybrids with different maturity classes, high yield potential, combining resistance to *Striga* and drought tolerance, and other desirable traits in different countries in WCA, IITA has supplied parental lines of promising hybrids to private seed companies for further testing, production, and commercialization. The institute has also trained technical and management staff of seed companies to strengthen their human capacity to produce and market hybrid maize (NAERLS, 2009).

In addition, IITA has promoted community-based seed production schemes through its work with WECAMAN and more recently with diverse partners to make improved seeds available to farmers in countries where the private sector is less developed and in areas with limited access to markets. Despite the impressive strides that have been made so far, continued investment in maize productivity research still remains critical to sustain agricultural growth, food security, improved nutritional quality, and safe harvests. Considering the predominance of the crop in diverse farming systems, heterogeneous landscapes, and the diets of millions of people in WCA, enhanced yield gains have the potential to further expand production in WCA, thus contributing to bridging the gap between food supply and demand in the region, because research has led to and will continue to deliver excellent results (Kamara *et al*., 2006).

2.4 Importance of Maize in National Development

Increased investment not only in research but also in strengthening the private seed sector will still be needed to promote the rapid turnover of maize hybrids on farmers' fields that help to achieve higher yield gains to support improved farming. Maize nourishes her family at every meal. It's also her main source of income, giving her money to send her children to school, visit the doctor, and put a roof over her head (Kamara *et al*., 2006). But the impacts of climate change are threatening this life-giving

crop for Numbi and millions of other African farmers. Severe droughts in recent years have scorched millions of hectares of maize across the continent, pushing farming families like Numbi's into poverty and hunger. It's been very difficult to keep practicing farming when the weather is not good," says the 37-year-old mother of two. New varieties of maize, however, are giving her something once unimaginable: insurance against hunger (Kamara *et al*., 2006).

The maize varieties can withstand drought, allowing them to thrive even when there is no rain. This was developed by the Mexico-based International Maize and Wheat Improvement Center (CIMMYT) and the International Institute of Tropical Agriculture (IITA), with the support of the foundation and a broad range of other partners, these drought-tolerant maize varieties are giving African farmers powerful tools to adapt to the changing climate. More than 2 million smallholder farmers in Africa are already realizing the benefits of higher yields and incomes from these new maize varieties (UNSCN, 2010). By 2016, the drought-tolerant maize program is expected to boost maize yields by as much as 30 percent, benefitting up to 40 million people in 13 Sub-Saharan African countries. After struggling through several droughts over the last decade, Numbi planted drought-tolerant maize in 2009. Her crop yield tripled from 15 bags (1.5 tons) per hectare to 45 bags (4.5 tons) per hectare. Thanks to bumper harvests, Numbi has plenty of maize to feed her family plus some extra to sell in local markets. She earned enough money to pay school fees for her two children, finish a new mud brick house, and build a chicken coop (UNSCN, 2010).

A 2010 study by CIMMYT and IITA found that widespread adoption of recently developed drought-tolerant varieties of maize could boost maize harvests in 13 African countries by 10 to 34 percent and generate up to $1.5 billion (U.S.) in benefits for producers and consumers. "Our improved maize varieties are helping farmers improve

their productivity and generate more income and fight hunger and malnutrition," says IsakaMashauri, CEO of Tanseed International, a Tanzanian seed dealer working with CIMMYT to produce drought-tolerant maize seeds (UNSCN, 2010).

Getting these improved maize varieties into the hands of African farmers like Katsina State is the product of more than two decades of research and involves a broad coalition of partners, from governments and NGOs to seed dealers and farmers. The most important members of this partnership, however, are the farmers themselves. Improved crops can't help farmers unless farmers want to use them. That's why drought-tolerant maize varieties are all subject to review by African smallholder farmers before they are sold. The farmers have not been afraid to let their opinions be heard (UNSCN, 2010). In Malawi, the government introduced various improved maize varieties for farmers to test out in their fields. Of these, the farmers preferred an early maturing drought tolerant variety over others. In a year of severe drought, early maturing drought-tolerant varieties offer added insurance against starvation. Malawi's ministry of agriculture officials took note, and the government endorsed the variety preferred by the farmers, encouraging thousands of farmers' toadopt it in the country's drought-prone areas (UNSCN, 2010).

The benefits of drought-tolerant maize are also making it increasingly popular among farmers in Tanzania. The tall, healthy stalks of maize rising from Numbi's fields are one of its best advertisements. Whenever other farmers stop to admire her maize, Numbi says, "I advise them to adopt this variety if they really want to change their lives. According to UNDP (2006) as climate change intensifies drought conditions in Africa and generate fears of a new cycle of crippling food shortages, widespread adoption of drought-tolerant varieties of maize could boost harvests in African countries by 10 to 34 percent and generate up to US$1.5 billion in benefits for producers. There is the need to

move deliberately, but with urgency, to get these new varieties from the breeders to the farmers, because their potential to avert food crises is considerable. In the same report by UNDP with high rates of adoption, more than four million producers and consumers would see their poverty level drop significantly by 2016.

Moreover, the researchers estimate that if drought-tolerant maize completely replaced existing varieties in the countries studied, the benefits could reach US$1.5 billion. Farmers and consumers in Kenya, Malawi, Zambia, and Zimbabwe would see the greatest benefits, the authors note, because maize dominates local diets and livelihoods, and farmers in these countries have a history of rapidly adopting improved maize varieties. The goal is to make drought-tolerant maize easily available to millions of smallholder growers in countries where droughts, which always lurk as a perennial threat to food production, are expected to become more common and more severe (UNSCN, 2010).

2.5 Drought Tolerant Maize for Africa (DTMA)

Development, deployment, and cultivation of drought tolerant maize varieties can significantly benefit sub-Saharan Africa's maize farmers and consumers. This was the general finding of a study Potential Impact of Investments in Drought Tolerant Maize in Africa by The International Maize and Wheat Improvement Center (CIMMYT, 2009). Sub-Saharan African farmers can benefit about US$0.9 billion during 2007-16 from drought tolerant maize. "Those varieties provide a yield advantage of 10 to 34% over normal improved varieties, depending on the site and seasonal conditions (FMARD, 2001., Bamire, 2007).

Access to improved seeds by smallholder farmers is a prerequisite to increased maize production in West Africa, as climate change hurts yield from traditional varieties, says

a study by researchers working under the Drought Tolerant Maize for Africa Project (DTMA). Tahirou *et al.* (2007) noted that improved maize varieties tolerant of drought are helping farmers in addressing production risks; in recent years has been severely threatened by frequent droughts and irregular rainfall. In West and Central Africa, 35% of the area under maize is affected by drought.

The DTMA Project, a partnership led by the International Center for Maize and Wheat Improvement (CIMMYT) and IITA, is helping farmers in cushioning the negative effect of drought by developing and disseminating maize with significantly improved drought tolerance. Tahirou *et al.* (2007) found that although seed companies that are critical to the dissemination of seeds in West Africa have expanded since 2007 from about 10 formal companies to more than 22 currently in the four DTMA countries (Nigeria, Benin, Mali, and Ghana); their production remained below demand. For instance, the total production of improved maize seeds in those countries stands at about less than 15,000 tons while more than 80,000 tons are required for Nigeria alone (FAO, 2009). Presenting the findings to stakeholders at the regional meeting of DTMA partners and policymakers in Lagos, affected governments in the region were urged to tackle the challenge of poor irrigation to pave the way for an all-year-round production of improved seeds to accelerate availability and meet farmers demand (FAO, 2009).

While commending member countries for adopting fairly liberal seed laws, the Economic Community of West African States (ECOWAS) were advised to step up efforts that would see the full implementation of the harmonized regional seed law.“This will help countries that are lagging behind, as improved drought-tolerant maize varieties will move freely across the region,” Equally important for governments in the region is to help seed companies gain access to working capital.The United Kingdom’s Department for International Development (DFID) has won Best

Technological Breakthrough at the UK Climate Week Awards for its support to a project to develop drought-tolerant maize in Africa. The prize was announced at the Climate Week Awards, held in London to celebrate the UK's most effective and ambitious organizations, communities, and individuals and their efforts to combat climate change (FAO, 2009).

Drought Tolerant Maize for Africa (DTMA), the winning initiative is responsible for the development and dissemination of 34 new drought-tolerant maize varieties to farmers in 13 project countries Angola, Benin, Ethiopia, Ghana, Kenya, Malawi, Mali, Mozambique, Nigeria, Tanzania, Uganda, Zambia, and Zimbabwe between 2007 and 2011. An estimated 2 million smallholder farmers are expected to adopt drought-tolerant maize varieties to obtain higher yields, improved food security, and increased incomes (FMARD, 2001). This maize is like an insurance against hunger and total crop failure, even under hot, dry conditions like those of recent years. It is noted that without good quality maize seed, you cannot earn enough, you cannot have life. In a continent where maize is the staple crop for over 300 million people and nearly all of it is grown without irrigation, relying solely on precipitation, drought tolerant varieties are invaluable.

In 2011 alone, more than 12.5 million people suffered the effects of drought and resulting famines in Africa, with the drought being termed the worst in 60 years (FMARD, 2001). The DTMA project uses conventional breeding, where varieties with good drought tolerance characteristics are cross-bred to get final products which are both productive and nutritious and grow well in African conditions. In particular, the DTMA provide farmers with better yields than leading commercial varieties under moderate drought conditions, while giving outstanding harvests when rains are good.

Partners in developing, marketing, or distributing seed include private companies, publicly funded agricultural research and extension systems, ministries of agriculture, non-governmental organizations, and community-based seed producers. Jointly implemented by the International Maize and Wheat Improvement Center (CIMMYT) and the International Institute for Tropical Agriculture (IITA), the DTMA project is presently funded by the Bill & Melinda Gates Foundation (BMGF) and is also receiving complementary grants from the Howard G. Buffet Foundation (HGBF) and the United States Agency for International Development (USAID, 2009).“DFID has been a highly-valued and reliable, top-ten core contributor to CIMMYT’s work. In the case of maize research, four-tenths of our funding is targeted to Africa and most goes to develop stress tolerant maize varieties and more resilient farming systems for maize and associated crops. DFID also provided ten years of valuable support for mid-altitude maize breeding program for southern Africa, which focused on drought tolerance.

2.6 Drought, its Occurrence and Economic Implications

Drought is a condition in which the available moisture at a certain location falls sufficiently short of the normally expected such as to constrain the agricultural activities that have been adapted to the particular location (Owonubi and Abdulmumin, 1985). Drought remains the single most important factor threatening the food security of peoples in the developing world. Drought stress arising from uneven distribution of rains during the rainy season or total cessation of rains during the growing period may occur at any of the four distinct growth stages (i.e. seedling, vegetative, pre-anthesis and post-anthesis) especially in cereals. Among the economic implications of drought world wide are: (i) severe food shortage with its associated spiraling of food prices,(ii) famine, (iii) destruction of export crops which ruins the export economy, (iv) forced

emigration of victims to more favourable environments which may be of different culture and organization as well as refugee problems (Enabor,1985).

Drought has occurred in Nigeria for a considerable long period and some writers have suggested a l0-year cycle with considerable variations in severity (FMARD, 2001). Although there is abundant empirical evidence to show that the recurrent patterns of drought is not peculiar to the savanna agro-ecologies of Nigeria, its effects have always been more severe and devastating in these ecologies than in the south. The fact that there is persistent crop failure arising from drought in these ecologies therefore necessitated the development of drought tolerant (DT) crop genotypes for cultivation in the zone. This is because the breeding and eventual release of DT crop varieties for cultivation in drought-prone ecologies is the cheapest and safest insurance against crop failure in such environments. In other words, improving the DT capacity of crops meant for cultivation in these ecologies should be a major objective of the plant breeders whose mandate includes the development of crops meant for cultivation in drought-prone ecologies without irrigation. One way to achieve this objective is to build moisture-stress tolerance attributes into such varieties in order to stabilize crop yields in those environments and promote its adoption (Jensen, 1994).

The CIMMYT-IITA analysis of the benefits of conventional drought-tolerant maize for Africa (DTMA), examined the potential impact of this maize to the livelihood of its producers in Angola, Benin, Ethiopia, Ghana, Kenya, Malawi, Mali, Mozambique, Tanzania, Uganda, Zambia and Zimbabwe. The researchers found that under conservative yield improvements, the new varieties would provide farmers and consumers with food and income worth US$537 million (₦116,529) million, while under more optimistic yield improvements, their value would increase to US$876 million (₦190,092) million (FAO, 2009). Moreover, the researchers estimated that if

drought-tolerant maize completely replaced existing varieties in the countries studied, the benefits could reach US$1.5 billion (₦325.5) billon. In a peer-reviewed study published by Stanford University and the Global Crop Diversity Trust warned that by 2050, growing conditions in most African countries will be hotter than any year on record and that many varieties of maize now under cultivation will no longer be viable (FAO, 2009).

Another study from the International Livestock Research Institute (ILRI) warned that a failure of transition to drought-tolerant maize could diminish yields across the region by up to one ton per hectare (FAO, 2009). Farmers and consumers in these countries would see the greatest benefits of the DTMA varieties to their livelihood the authors noted that, because maize dominates local diets and livelihoods; the goal now is to make drought-tolerant maize easily available to millions of smallholder growers in countries where droughts, which always lurk as a perennial threat to food production, are expected to become more common and more severe.

While commending maize breeders for developing drought tolerant maize varieties for drought prone areas of Nigeria there is the need to deliberately step up efforts that would see the full implementation of the adoption of these varieties. This will help countries that are lagging behind, as improved drought-tolerant maize varieties will move freely across the region. A vision which aims to develop varieties that would give farmers, at least, one tonne per hectare more maize when drought hits, improve smallholder farmer maize productivity by between 20 and 30 per cent, and reach between 30 and 40 million people in Sub-Sarahan Africa with these new maize varieties. Moreover, researchers estimate that if drought-tolerant maize completely replaced existing varieties in the countries studied, the benefits could reach US$1.5 billion (UNSCN, 2010).

2.6.1 Drought resistance in crops

Terminologies in drought research: Arraudeau (1989) identified five terms often used by breeders in drought research. These are drought resistance, drought escape, drought avoidance, drought tolerance and drought recovery. Drought resistance is the ability of the plant to live, grow and yield satisfactorily with limited water supply or under period of water stress.

Developing drought tolerant crop varieties for the savanna Agro-ecologies of Nigeria is the plant's ability to mature before stress becomes a seriously mitigating factor is referred to as drought escape. Drought avoidance on the other hand is the ability to maintain high water status during drought. Drought tolerance refers to ability to withstand water deficit as measured by degree and duration of growth of plant-water potential while drought recovery is the ability of a plant to resume growth and yield after drought stress, with a minimum of irreversible yield loss (Arraude, 1989; Bidinge and Witcombe, 1989).

The development of extra-early maturing varieties enabled production to expand into new areas, especially to the Sudan savannas where the short rainy season hitherto had precluded maize cultivation. The highest growth in maize area, yield, and production in Sub-Saharan Africa since 1961 occurred in WCA. These productivity gains, achieved through farmers' adoption of improved varieties in the 1980s, were driven by the suitability of the cultivars to the major production environments, the availability of inexpensive fertilizer and extension services, as well as favorable government policies that encouraged the use of these technologies (Arraude, 1989; Bidinge and Witcombe, 1989).

2.6.2 Approaches to drought research in maize

Several approaches have been suggested as measures to the negative effect of drought on maize production. The approach to drought research include (i) growingr more DT crops,(ii) breeding more drought-resistance to crops, (iii) breeding for heat tolerance in crops,(iv) incorporating enesf or resistanc to prevalence to DT genotyp) the use of complementarycrop management practices that promote the adoption of cultivating DT genotypes (Arraudeau, 1989).

The cultivation of DT genotype has been described as the cheapest and safest means of averting crop failure in semi arid and low-moisture areas of the world. In the U.S.A, Jansel (1994) attributed part of the gains in maize yields during the drought years of the 1980's to genetic improvements.Similar yield advantages through the adoption of DT-maize genotypes have been reported in some parts of East and Central Africa (Njoroge, 1994).ln the drier areas of theWest African Coast the release of early and extra early maize varieties for cultivation has contributed immensely to increased 'maize production in those ecologies (Anon, 1999).

In a recent impact assessment study conducted in nine countries, the number of maize varieties annually released in West and Central Africa (WCA) had increased from fewer than one in 1970s to 12 in the late 1990s. The availability of such high-yielding and adapted varieties resulted in a 2% annual increase in land area planted to maize and a 3.5% annual increase in grain yield from 1971 to 2005 (Martin, 2008). Among the varieties released from 1998 to 2005 in the nine countries, 67% were derived from IITA's maize germplasm. Of the 4 million ha planted to improved maize in these countries, about 43% of the area was planted to varieties derived from IITA's germplasm. The joint International Institute for Tropical Agriculture-National Agricultural Research Scheme (IITA-NARS) investment in maize research in the nine

countries had lifted an average of 1.6 million people out of poverty annually from 1980 to 2004. Further more. White's study on impact of adoption of yellow maize in Ghana adopted a regressions moadel to show the impact on improvements in the physical quality of livelihood, and of on outcomes of maize adoption in Ghana (Martin, 2008, White, 2009).

2.7 Constraints to Adoption Studies

While working with diverse partners to promote the dissemination of maize varieties in the various countries, IITA realized that the major constraint to the adoption of improved varieties in WCA was the absence of an effective seed production and delivery system.Although the early diffusion adoption research studies covered such diverse fields as communication and marketing, rural sociology, anthropology, education, industry, and the medical sciences, the major bulk of the studies have come from the rural sociology discipline (Atala, 1980; Arokoyo, 1981).

It should be pointed out however, that the rural sociology work on the diffusion and adoption of innovations, is traceable to two significant antecedents viz: the felt need of the newly established united states cooperative extension service in 1914, to evaluate its activities in terms of changed behaviour of farmers as a measure of their adoption of the recommended farm practices by the extension service; and secondly, the work of anthropologist interested in investigating the spread of cultural traits between different cultural groups. (Arokoyo,1981).

Besides low price responsiveness in the local maize market, there are several other constraints that deter farmers from adopting agricultural production technologies through increased use of yield-enhancing inputs. These include volatility in external markets; high input costs arising from high transactions costs of input trading; and limited supply (availability) of inputs. Many of the external markets for most

agricultural commodities have in the past been characterized by volatility with trade booms at one time immediately followed by busts. For instance there was a maize trade boom in Uganda in the early 1990s with 'gold-rush' characteristics, including a sudden increase in demand, the entry of many new traders, a rapid and large increase in price, only to be followed by a subsequent collapse in prices and bankruptcy of many of the new and already established traders (World Bank, 1996). The farmers' losses were even worse, and given the low risk bearing ability of poor smallholder farmers, their continued participation in maize export markets is seriously threatened by the volatility of these markets.

The other problem that may prevent farmers from adopting maize technologies is lack of access to the technologies. Maize does not have an effective regulatory body to set and enforce quality standards. Different varieties of maize with different characteristics are often mixed together, and quality-testing equipment is lacking at the local level. Prices for the most part do not appear to reward quality, and to the extent that it exists, the premium for quality does not appear to be sufficient to induce investment in quality improvement (Nkonya, 2002). Lack of standardization and quality control also limits the range of products on the market that use maize as a raw material, compared to its substitutes like wheat. This limits the size of the maize market as well as its responsiveness to prices. Without developing new maize-based products and markets for these products, the utilization base for maize will remain low and will continue to limit the size and price responsiveness of the local maize market (UNSCN, 2010).

Lack of storage and processing infrastructure causes high post harvest losses and contributes tolow adoption rates of maize production technologies, on top of constraining the production of maize in the study area because a certain level of stock is needed to send an effective availability signal to the buyers of neighboring countries.

Lack of storage also increases the transaction costs of assembling, which greatly reduces the feasibility of maize export (UNSCN, 2010).

Besides the above-listed constraints to intensification on the output market side, the input markets for improved seed and fertilizer are also characterized by several constraints that prevent farmers from adopting these inputs. These include high costs and limited availability (supply) of these inputs.

CHAPTER THREE

3.0 THEORETICAL FRAMEWORK

This study was guided by the diffusion and adoption theory and impact assessment perspectives.

3.1 The Diffusion and Adoption Theory

Agricultural technologies include both physical objects such as seeds or fertilizer, as well as new farming methods. The technology may not be new as such, but novel to the farmer. Thus, Rogers (2003) noted that a new technology (or innovation) is as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption". Rogers (2003) identified two characteristics of innovations (from the perspective of the farmer) that best explain different adoption rates, i.e. the perceived relative advantage of using the technology vis-à-vis the technology it supersedes, and its perceived compatibility with existing values, needs and experiences (Rogers, 2003). In addition, Rogers notes that innovations are more likely to be adopted if they are less complex, lend themselves to trialability and whose results are observable to others.

Adoption of a technology may be measured by "both the timing and extent of new technology utilization by individuals" (Sunding and Zilberman, 2001). The extent of adoption can be measured by intensity of cultivation e.g. in terms of number of farmers, total area, area within farms or harvest (CIMMYT, 1993). Two main strands of technology adoption research have emerged (Marra *et al.*, 2003). Sociologists have traditionally focused on the characteristics of the adopters, their perceptions of the innovation, adoption rates and communication channels in the decision process. Griliches' seminal study of the diffusion of hybrid corn in Iowa was one of the first economic studies in this area which shifted the emphasis towards economic variables as the most important determinants of technology adoption (Griliches, 1957). Since the

1960s and in particular since the publication of the Griliches studies, S-shaped diffusion curves have become widely used (Sunding and Zilberman, 2001).

According to this theory, innovations are first adopted by a few early adopters. Then adoption rates accelerate as the majority adopts the technology before it gradually slows again as fewer and fewer remaining individuals adopt the innovation the so-called "laggards" (Rogers, 2003). In this context, diffusion studies have focused on the differences between early and late adopters, the perceived attributes of an innovation that affect its rate of adoption and why a critical mass of early adopters is needed for an innovation to become widespread.

Experience has shown that a new technology may not be appropriate in every context, but rather its suitability depends on how well it fits the particular farming context (CIMMYT, 1993). However, much of the focus of the adoption literature has been on the individual farmers (e.g. the attitude or personality of the farmers or their socio-economic characteristics, such as wealth, landholding or education) and the characteristics of the technologies, rather than the context in which technology adoption and diffusion takes place (CIMMYT, 1993; Marra *et al.*, 2003). It is also important to note that the adoption process is a dynamic one, not only in terms of the diffusion of new technologies over time and space, but also from the perspective of the individual farmer.

As a result, the willingness and ability to adopt new technologies, the relative weight of the influencing factors and the associated needs for support may change over time. For instance, the willingness to adopt may change with age and experience (CIMMYT, 1993). Older farmers may be less willing to invest in technologies that only pay off in the longer term (Feder and Umali, 1993) but may also have more resources to invest in

new technologies. Younger farmers on the other hand may be more educated or be more open to trying out new technologies. Moreover, farmers often modify their perceptions of the riskiness of new technologies over time as they acquire more information (Marra *et al.,* 2003).

Also, adoption is not necessarily a binary decision. Rather, the intensity of adoption may change over time, for instance as a result of learning or through better access to farm resources. Some technologies may also be abandoned again (CIMMYT, 1993). There are, also some evidence of a 'technological ladder'. Kaliba *et al.* (2000) noted that the majority of adoption studies had found that smallerholder farmers tended to adopt simple technologies first before moving on to more complex ones, while cheaper technologies may be adopted before the more expensive ones. Moreover, over the past two decades researchers have been increasingly recognising the need to look at agricultural technologies as a package where farmers may adopt components at different times and speeds (Feder and Umali, 1993). This theory was used to guide the analysis of factors influencing the adoption of DTMA by maize farmers in Katsina State.

3.2 The Concept of Impact Assessment

The approaches to impact evaluation can be divided up in various ways. Amongst practitioners of rigorous impact evaluation the discussion currently focuses on the merits and drawbacks of experimental approaches and the usefulness of the alternatives (White, 2009). But before getting to that discussion it is worth spending a moment considering non-statistically based approaches. IEG supports quantitative impact evaluation, but lessons can be drawn from these other approaches. Along with rigor, IEG's approach is characterized as strongly rooted in the context of the intervention in a way intended to produce policy relevant results. In practice this means adopting a

theory-based evaluation design. An appreciation of how to do this is just as important to a good impact evaluation as an understanding of the appropriate statistical technique.

3.2.1 Theory-based approach to impact evaluation.

According to the Oxford dictionary, the action of one object coming forcibly into contact with another. The dictionary described impact as marked strong effect or influence or to have a strong effect on someone or something. Martin (2008) theory-based evaluation design is one in which the analysis is conducted along the length of the causal chain from inputs to impacts. Many impact evaluations concern themselves only with the final link in the chain: final outcomes. But to do this, it is often to lose the opportunity to learn valuable policy lessons about why an intervention has worked (or not), or which bits have worked better than others (Martin, 2008; White, 2009). Applying a theory based approach requires mapping out the channels through which the inputs are expected to achieve the intended outcomes. In many cases this analysis will already be contained in the project log frame.

The log frame (Martin, 2008) may also specify indicators at the various levels. Indeed the monitoring and evaluation (M&E) system may have collected these indicators for project areas, and can be a useful source of analysis of process aspects of the intervention. A theory-based approach examines the links in the causal chain. Were there missing or weak links? There can be missing links if the project design missed some key determinants at the next level it should have sought to influence. For example (White, 2009) show that the nutrition project in Bangladesh attempted to change child feeding practices by providing nutritional counseling to mothers, but there are other actors who play at least as an important part in the decision making process, so the failure to include them constituted a missing link (White, 2009). Social funds make assumptions about the nature of the community and community participation which are

frequently not valid, so that the selected projects may not be the priority for a large proportion of the beneficiary population (World Bank, 2002). There may also be weak links in the chain as a result of poor implementation.

The most usual approach to measuring impact is to examine the mean value of the indicator of interest in project and control areas, attributing the difference to the project. The regression based approach can give an identical estimate to the single or double difference approaches (Martin, 2008; White, 2009) by use of a project dummy; that is a zero-one variable taking the value of 1 for observations in the project area. However this approach tells us nothing about the channels through which the project has its impact, and so is in general not consistent with the general philosophy of the theory-based approach. Regressions can help open the black box through a two, or more, stage process. Impact can be examined by modeling the determinants of the outcome of interest. This approach can draw on well-established literatures modeling those outcomes (Martin, 2008; White, 2009).

Amongst the explanatory (Ys), the dependent variable and (Xs) the independent variables will be factors which are affected by the intervention. Knowing how much an explanatory variable has changed as a result of the intervention (which may be determined by examining double differences for that indicator or itself be subject to regression analysis) allows calculation of the project effects via that particular channel. This is the approach taken in the most recent IEG studies. The project may have its effect not only by changing the quantity of a factor but its productivity. Regression analysis can readily accommodate this possibility by allowing the coefficient on the variable to vary before and after the intervention (Martin, 2008).

The contribution of the changes in quantity and productivity can be calculated separately. When using the regression-based approach two points need be borne in mind. First, there have been important developments in micro-level statistical analysis in recent years, so the evaluator need be familiar with 'the state of the art' in their particular area in order to retain credibility. Second, the regression based approach may not remove the problem of selection bias. But it can do so if selection is based on observables, provided data are available on these observables and the selection process is correctly modeled (Martin, 2008; White, 2009). Hence it is very important that the evaluator be aware of who benefits from the intervention. There are a variety of statistical approaches which can be used to eliminate the selectivity bias.

3.2.2 Double difference estimates (DDE)

The difference between the outcome in the treatment group (project area) and comparison group is a single difference estimate. The validity of this estimate as an estimate of project impact requiresthat the treatment and control groups had the same values ofthe outcome prior to theintervention. If this is not so then the single difference estimate will be biased. If the treatment group already had superior outcomes prior to the intervention then their better performance post-intervention cannot all be attributed to that intervention.

The double difference, which is the difference in the change, or, equivalently, the change in the difference allows for this possibility.Double differencing removes time invariant differences in factors influencing the outcome between the project and comparison groups. However, the validity of the double difference estimate stillrelies upon the assumption that external determinants of the outcome were the same for treatmentand comparison groups during the course of the intervention. For example, for an agricultural project, both groups (areas) should have experienced similar rainfall

patterns. Where these factors have varied then a regression based approach can control for these differences if they are observed (Martin, 2008; White, 2009). Hence data collection need cover not only the indicators directly relevant to the project, but alsoother determinants of the outcomes (and intermediate outcomes) of interest. However this statistical tool was not used because of the type and method of data collection used in the study.

The attractiveness of double differencing is a main reason for the desirability of baseline data.Another advantage is that information on the pre-intervention characteristics of beneficiaries allows analysis of targeting and addressing the simple factual question of changes in outcomes amongst beneficiaries. In addition to base-line and end-line surveys, a mid-term survey is advantageous. Such a survey will allow an initial check on impact, and also allow analysis ofchanges in impact overtime.

3.2.3 The Logical framework (log frame)

The logical framework was designed as a project planning tool, describing how it is that the inputs will achieve the desired objectives. The terms used vary by agency, but broadly correspond to inputs, activities, outputs, and outcomes. Indicators are defined as part of the log frame matrix which measure performance in delivering inputs, carrying out activities, producing outputs and achieving outcomes.

The logical framework used by the World Bank is a dynamic 4 X 4 matrix (Martin, 2008; White, 2009; World Bank, 2002). The first column represents the project goal, objective, output (or deliverables) and activities. The second column specifies how to measure whether the activities, outputs and outcomes of the project have been carried out and accomplished. It contains the monitoring and evaluation indicators, including the targets. In the third column the sources of information for the indicators are identified. This column describes the monitoring and evaluation system.

The fourth column lists the assumptions which are critical for the success of the project, but which are out of the project's control. Project summary Goal the higher overall goal to which this project (together with other programs) will contribute. Project objective indicatethe specific impact of the project: changes in welfare outcomes, or improvements in institutional performance (the intended / assumed effect of the project outputs).

The project intervention: The outputs and deliverables that the project (team) are held accountable for. The specific activities that have to be carried out in order to accomplish each respective project output are considered.Key performance indicators show few indicators that measure whether the project outputs have had the intended impact on beneficiaries or not. Output indicators measure the value added of the projectwhile input indicators are usually the financial, physical and human resources needed to carry out the activities (White, 2009). Most literature advocates more widespread application of a theory-based approach to impact evaluation as a means to improve policy relevance of Impact Evaluations. This study was concerned with the theory-based approach to impact evaluation to assess the effect of adoption of DTMA in Katsina State Nigeria.

3.3 Empirical Review of the Concept of Effects

According to the British Dictionary definitions for effect, it is the power to produce results, efficacy, force to produce as an effect. The dictionary further described effect as the power to bring about, accomplish, make happen, validity, influence the making of a desired impression on outcome that is, power or ability to influence or produce a result or efficacy.

Effect can also be said to be a consequence (s) or result which refer to something produced by an action or a cause. An effect is that which is produced, usually more or

less immediately and directly, something that is produced by a cause or agent. Studies on effects of technology adoption are therefore an appropriate approach which would guide in determining the result of adoption of drought tolerant maize for Africa on maize farmers output, income and level of living. This would provide data on the need to bring about, accomplishment validity and level influence the desired impression on the outcome and ability the DTMA adoption by farmers was able to influence or produce as a result of efficacy to its adopters.

According to Abdoulaye *et al.* (2014) in a study of the effect of awareness and adoption of improved cassava varieties and processing technologies in Nigeria showed that the use of improved cassava varieties and use of grating machines had positive effects on adoption in the single equation estimation. Also membership in community organizations, membership in cooperatives organizations, awareness of the benefits associated with the adoption of the improved varieties, and the proportion of cassava grated had significant effect on adoption. Membership in community organization showed a positive effect in increasing the probability of adopting improved cassava varieties by 0.28 percent.

In a study by Awotide *et al.* (2012) on effect of improved agricultural technology adoption on sustainable rice productivity and rural farmers' welfare in Nigeria showed that despite the higher area cultivated by the non-adopters, they seem not be better-off in terms of household income. For instance in their study, the adopters had a significantly higher income from both the production of rice and other crops than the non-adopter; consequently the adopters were also able to spend more (N95151.92) on agricultural production than the non-adopters (N72215.08). In terms of the effect of adoption of improved rice varieties on the welfare of adopters and non-adopters the result revealed that the consumption expenditure of the adopters (N9877.71) was higher

than that of the non-adopters (N9588.92). This implies that the adopters had a better welfare than the non-adopters.

The above result could be interpreted that the change in rice productivity was attributed to a change in improved agricultural technology status. The result also revealed further that the effect of adoption was much higher among the female headed households (445.46kg/ha) than the male headed households (154.90kg/ha). Furthermore, the effect was also higher among the poor farming households (648kg/ha) than the non-poor farming households (442.78kg/ha).

In this study, effect of adoption of drought tolerant maize was measured as the quantity of output obtained from the maize produced, income obtained from the sales of maize and changes in farmers' level of living as a result of involvement in DTMA production.

3.4 Conceptual Model for the Study

From the view of theory of adoption, a conceptual model for the study was derived from the synthesis of the theories to ensure that the findings of this study get substantial evidences. The model for exploring this study is made up of dependent variable (adoption of DTMA varieties) and the independent variables (socio-economic, institutional and technological attributes). For this study, the conceptual model posits that socio-economic, institutional, and technological variables would influence adoption of DTMA varieties. From the model, the interplay of the dependent and independent variables is expected to affect yield, income and level of living of maize farmers.

3.1 Conceptual Model

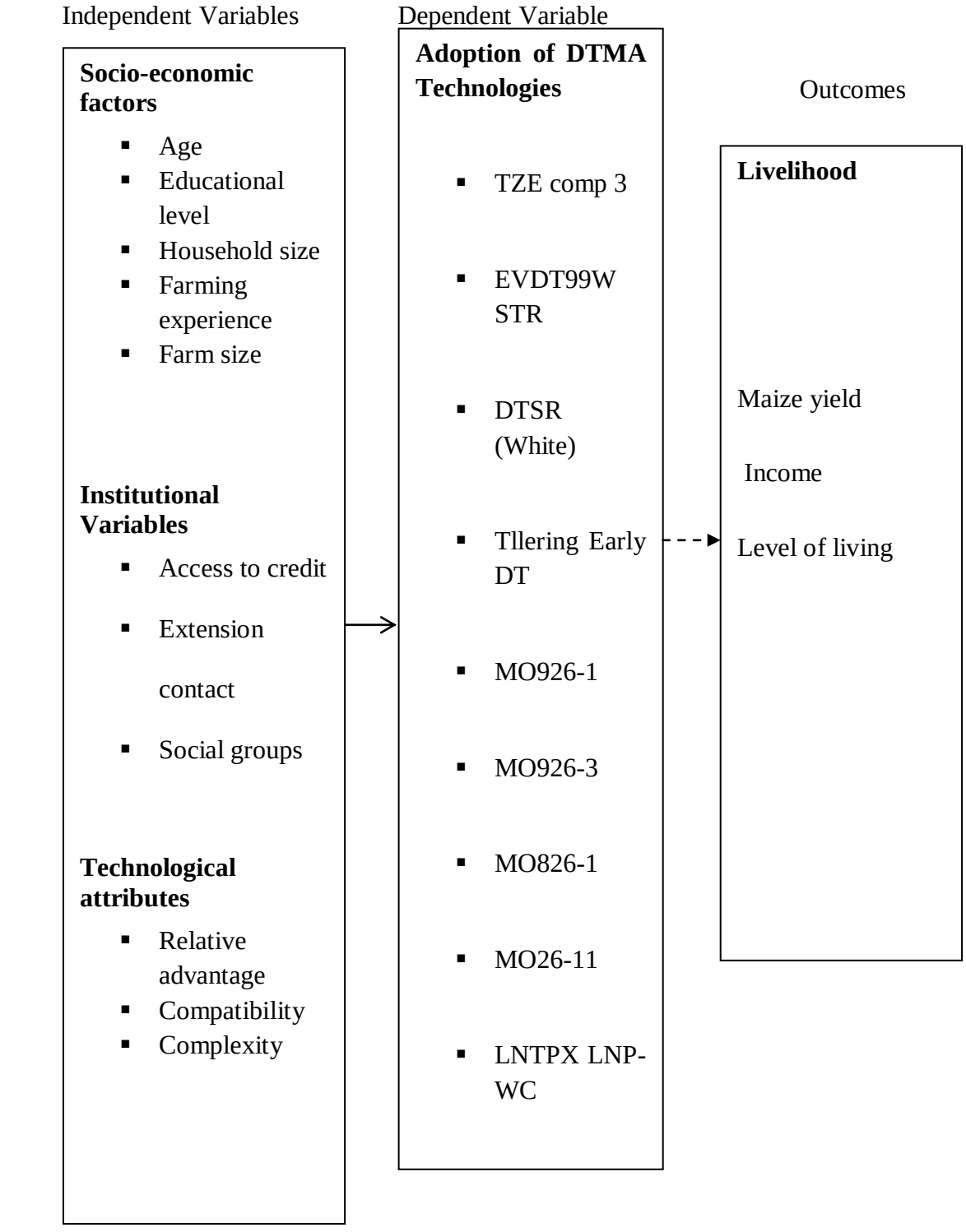


Figure 3.1: A model of factors affecting adoption of DTMA production technologies and its effects on maize famers' livelihood

CHAPTER FOUR

4.0 METHODOLOGY

4.1 Study Area

The study area is Katsina State. Katsina State of Nigeria lies in the north western part of the country's geopolitical zones, about 400km away from Abuja the Federal Capital. It is located between latitude 13^0 10″ north and 11^0 30″ and longitude 07^0 and 9^0 41″ east of the equator respectively. Katsina State shares boundaries with Kano State to the north-east, Zamfara and Sokoto States to the north-west and Kaduna State to the south (KTARDA, 2007). Katsina state is located within the northern Sudan Savanna of Nigeria and shares boundary with Niger Republic also.

The State has an estimated population of 6.67 million based on the 2006 provisional population census figure and an agriculturally active population of farm families projection of 471,000 who cultivate an average farm size of 1.8 ha (KTARDA, 2007). Based on the 2006 population figures the current population as at 2015 is projected at about 7,028,659 people comprising of 644,013 farm families. The annual rainfall of the state ranges between 420mm to 1000mm and temperature is averagely warm throughout the year at about 27^0c $\pm$ 7^0C. The natural vegetation of the environment is Sudan Savannah which is tropical grass-land with scattered trees such as baobab, acacia and locust bean trees (KTARDA, 2007).

The cropping system is mostly undertaken under the rain-fed and irrigated conditions and majority of farmers are small-scale holders who grow their crops solely or in mixtures with less than 2.5 hectare^{-2} farming household. The upland crops commonly grown are millet, sorghum, groundnut, cowpea and maize. The low-land fadama crops grown in the state includes tomato, onions, pepper and other vegetables with rice and wheat grown in the flood-plains and irrigated dam areas. Drought-tolerant maize is a

critical poverty reduction crop especially in Katsina State where rainfall is unavailable and frequently less than that required for a good maize crop. Annual requirement for maize has been estimated at about 14 million metric tones (NAERLS, 2009).

4.2 Sampling Procedure and Sample Size

A multi-stage sampling technique was used in selecting the respondents. In the first stage, three agricultural extension zones where Katsina State Agricultural and Rural Development Authority (KTARDA) operate, were, purposively selected based on high level of participation in the DTMA programme in the State. In the second stage, six LGAs (Kaita, Mani, Ingawa, Dutsin-Ma, Musawa and Faskari) were purposively selected from these zones to represent the LGAs. In the third stage, 2 villages identified to be fully involved in the DTMA programme were purposively from each selected LGAs selected for the study and lastly 50 percent of the farmers found to have high participation in the DTMA activities were selected from each of the selected villages using Table of Random Numbers giving a sample size of 276 respondents from a sample frame of 544 famers.

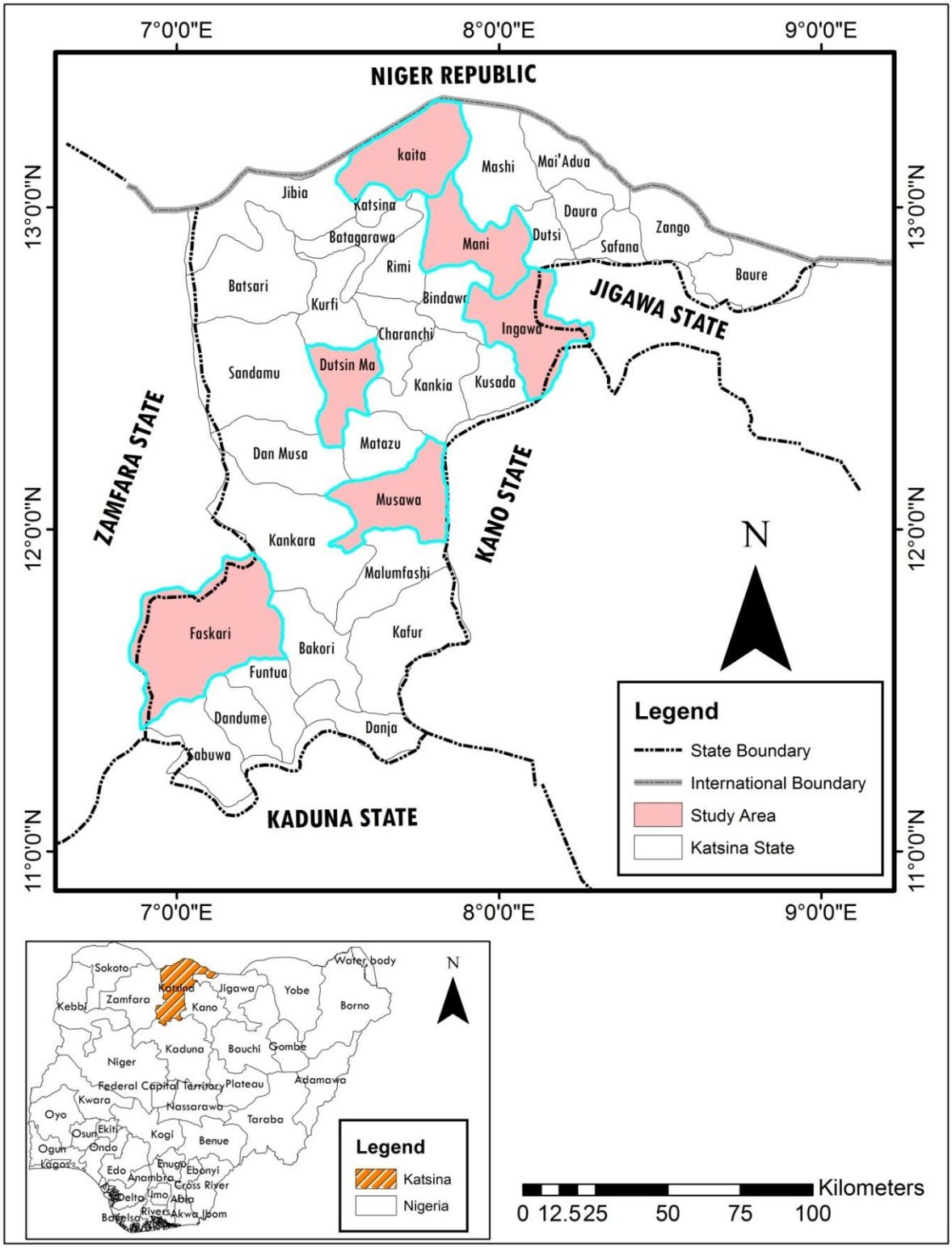


Figure 4.1: Map of Katsina State showing study area

Table: 4.1 Selected Study Areas According to LGAs and Sample Size

Agricultural Zones	LGAs	Villages	*Total number of DTMA Farmers	Randomly Selected respondents (50%)
A	Danmusa	Yantumaki	49	25
		Danalkima	42	21
	Bindawa	Tama	59	30
		Danlaji	51	26
B	Musawa	Musawa	48	24
		Danjakun	37	19
	Faskari	Daudawa	44	22
		Nasarawa	47	24
C	Dutsinma	Kurechi	39	20
		Dogon Ruwa	41	21
	Ingawa	Ingawa	45	23
		Yandoma	42	21
	TOTAL		**544**	**266**

***Base on reconnaissance survey, 2014**

4.3 Methods of Data Collection

Primary data were used in the study. The primary data were collected by interview method through use of structured questionnaire. The questionnaire instrument was administered to 276 randomly selected respondents. Information sought relates to the socio-economic characteristics of the respondents, respondents awareness of DTMA maize varieties in the study area, adoption of the DTMA varieties by the respondents, factors influencing adoption of the DTMA varieties by the respondents and the constraints in the adoption of DTMA varieties in the study area. The secondary data were obtained from the State Agricultural and Rural Development Authority (KTARDA), International Institute for Tropical Agriculture. Information sought relates

to records of activities of KTARDA on their extension activities in promoting the adoption of DTMA in the State and IITA reports on the DTA varieties released to the study areas.

4.4 Analytical Techniques

Descriptive statistics which comprise of measures of central tendency (percentages, mean, frequency distribution tables) and measures of dispersion such as variance were used to achieve objectives:i socio-economic characteristics of maize farmers, ii and iii levels of awareness and adoption of DTMA varieties and objective vi constraints in the adoption of DTMA varieties, the Tobit regression analysis was used to achieve objective iv factors influencing adoption of DTMA varieties by farmers and the ANOVA test was used to achieve part of objective v the effects of adoption of the DTMA varieties on farmers livelihood. The tobit regression is expressed as follows:

Tobit Regression Model

The Tobit model adopted for this study is based on the model adopted by Tobin (1958) specified implicitly as follows:

$$Y^* = \beta X + u \quad \text{---------- (1)}$$

Where X is a k-vector of regressors, possibly including 1 for the intercept and the error term u is normally N $(0.\sigma^2)$ distributed conditionally on X and Y*=dependent or latent variable with X as vector of regressors, possibly including 1 for the intercept and β the corresponding vector of the parameters.

The latent variable Y* is only observed if Y* > 0. The actual dependent variable is:

$$Y = \max(0, Y^*) \quad \text{…… (2).}$$

For this study, the Tobit model was applied as specified in equation (3).

The explicit form of the Tobit model is specified as follows:

$Y^* = bo + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + \ldots\ldots\ldots\ldots + b_{10}X_{10} + u$ …… …….. (3)

Where:

Y =Adoption of the each recommended maize technologies (Yes = 1, No.= 0)

X_1 =Age (Years),

X_2 =Educational level (Years),

X_3 = Household size (Number)

X_4 =Farm size (Hectare)

X_5 = Experience in DTMA farming (Years),

X_6 = Access to credit (Naira)

X_7 = Social groups (Number)

X_8 = Annual income (Naira)

X_9= Extension visits (Number of visits per year),

X_{10}= Relative advantage of DTMA varieties over local varieties (5 point likert type scale of strongly agree =5, agree =4, undecided =3, disagree =2, and strongly disagree =1)

X_{11} = Compatibility with norms and values of the society (5 point likert type scale of strongly agree =5, agree =4, undecided =3, disagree =2, and strongly disagree =1)

X_{12}= Complexity (5 point likert type scale of strongly agree =5, agree =4, undecided =3, disagree =2, and strongly disagree =1)

U= Error term

Analysis of Variance

The critical ratio 2 and the t-test are used to find out whether the means of two random samples are too different as to attribute the difference to chance or sampling error. When the samples or groups are more than two, the t-test is no more to be used, another ratio or statistics are used, it is called analysis of variance (ANOVA). It is a parametric test which means that all the parametric assumptions and conditions should also apply to it. The variance of the scores for all the groups combined into one composite group known as the total groups variance (V_2 or S_2) is obtained and the mean value for the variance of each group is calculated separately.

The analysis of variance may be used for two groups with probability values as the t-test. It is also used in testing significance of sample mean between three or more groups. Individuals in the sub-group should be randomly selected. The sample that will constitute each group should be independent. ANOVA is similar to the chi-square test, the Mann-Whitney U-test and the Z-test. It is an F-test and the main characteristic and the advantage of the F-test over these and other tests is that it is employed when more than two categories are studied. It is a single test that produces results that otherwise would have required several tests.

The formula for computation of ANOVA:

ANOVA = F

$$F = \frac{V_b}{V_w} \frac{between groups \text{ variance}}{within groups \text{ variance}} = \frac{S^2{}_B}{S^2{}_W}$$

Calculate the average of all of the sample variance

$$S^2 = \frac{s_a^2 + s_b^2 + s_c^2 + ...}{n}$$

Calculate the value of the F statistic :

$$F = \frac{nS^{.2}}{S^2}$$

Where:V_b is the between-sample variation,

Vw= the within-sample variation,

S= the number of categories, groups or samples,

n = the number of respondents in the group (not the total sample).

4.5 Definition and Measurements of Dependent and Independent Variables

4.5.1 Independent variables

Socio-economic variables

i. **Age**: The ability to learn fast and decide on certain key issues and act favourably to certain information depends on the age of the individual. Young people do understand faster than old people but older people have better ways of perception of the environment. To know the age of the individual, the actual age of the individual was measured in the actual age of the respondent.

ii. **Education**: Rogers and Shoemaker (1997) stressed that education is not only an important determinant of knowledge of an innovation but also an instrument for correct use of innovation for profitability. Education was scored as total number of years an individual had spent in a formal shooling:

iii. **Household size**: This was measured as the total number of people living in a household and sharing the same pot.

iv. **Experience in DTMA activities**: This was measured by the actual number of years the farmer had been into DTMA farming.

v. **Farm size**: Farm size was measured in number of hectares the farmer cultivates.

vi. Annual farm income refers to the total amount of money an individual farmer member obtained from DTMA farm.

Institutional variables

i. Extension contact: This is the number of contacts between extension officials and farmers. This was scored as :Yearly = 1,quarterly =2,bimonythly = 3,monthly = 4 and weekly = 5

ii. Amount of credit obtained: This includes the actual amount of money or its equal that an individual farmer obtained as fund for farming activities after adoption of DTMA.

iii. Social groups refered to the number of groups an indivial belonged as at the time of the study

Tecnological attributes

i. Relative advantage: this refers to the degree to which an innovation is superior to the one it is meant to supersede. This may be either in economic or social terms. This was measured using Likert- scale of five point scaling as strongly agree =5, agree =4, undecided =3, disagree =2, and strongly disagree =1.

ii. Compatibility: is the degree to which innovation is perceived as consistent with the existing values, past experiences and needs of farmers. This was measured using Likert- scale of five point scaling as follows, strongly agree =5, agree =4, undecided =3, disagree =2, and strongly disagree =1.

iii. Complexity: is the degree to which an innovation is relatively difficult to understand or use. An innovation that is relatively easy to understand will tend to be more readily adopted than the complex ones. This was measured using

Likert- scale of five point scaling as strongly agree =5, agree =4, undecided =3, disagree =2, and strongly disagree =1.

4.5.2 Dependent variable

The dependent variable was adoption of the seven (9) recommended DTMA varieties for production, and an adopter of a particular variety was a farmer who used that recommended DTMA variety on a continuous and large scale basis. Thus, a list of the DTMA recommended varieties consisted of TZE comp, 3EVDT99W STR, DTSR (White), Tllering Early DT, MO926-1, MO926-3, MO826-1, MO26-11, LNTPX LNP-WC. (Barmire, 2007). Out of this list, a farmer who reported the use of a particular varity was further asked to describe the scale of usage. It was only upon an indication of continuous and large scale usage that the farmer was credited as an adopter. This was facilitated by the extent of the farmer's knowledge of the variety and scope of usage. The adoption score was calculated by summing up the number of recommended varieties being adopted by the farmer.

4.5.3 Out come variables

Output: This was measured as the total output of the DTMA in 100kg bags harvested in 2014 cropping season

Income: Respondents' income was based on the amount of money received from maize produce sold during the last harvest. The products for all the income possessed by the respondents were summed up to give the individual farmer's income level score. This was measured as the total money in Naira that accrued to the farmer from DTMA production. Three categories of farmers were made as follows:

(1)Those with low level of income (100000-199000 naira),

(2)Those with medium level of income (200000-399000 naira) and

(3)Those with high level of income (over 400000 naira)

Level of living: Level of living is one of the important indicators of social status which is mostly found to be positively related with adoption (Rogers and Shoemaker, 1995). The level of living concepts refers to material and impersonal resources with which individuals can master and command their living conditions. This variable has been variously measured depending on the discipline and cultural setting. In this study, level of living score was computed for the surveyed farmers based on the durable assets listed in questions 64 of the questionnaire were acquired and possessed by an individual farmer as a result of adoption of DTMA technologies. The durable goods items were: (a) car (b) bicycle (c) motorcycle (d) radio (e) television (f) mobile phone (g) water pump (h) oxen (i) animal traction (j) tractor (k) generator.

Each item was given monetary value based on its current market value in 2012 as determined by the investigator from the market. The monetary value of each item was multiplied by the total number of the same items possessed by the individual DTMA farmer. The products for all the items possessed were summed up to give the individual farmer's level of living score. Three categories of farmers were made as follows:

(1)Those with low level of living (100000-199000 naira),

(2)Those with medium level of living (200000-399000 naira) and

(3)Those with high level of living (over 400000 naira)

This was measured by checking how many of the durable goods and livestock items possessed by an individual farmer as a result of DTMA production. The durable goods items were: radio, bicycle, motor cycle, car, refrigerator and zinc roof. The livestock items were:cows, goats, sheep, fowl, ducks, donkeys, horses, bush fowls and others. The value of each item was converted to its monetary worth as at the time of study.

CHAPTER FIVE

5.0 RESULTS AND DISCUSSION

5.1 Socio-economic and Insttitutional Characteristics of the Respondents

5.1.1 Age

Table 5.1.1 shows the distribution of respondents according to their age. Finding showed that, about 46 percent of the respondents fall within the age range of between 41–50 years. This shows that most of the respondents engaged in DTMA production are relatively within the middle age group. This age group could be said to have the resources or means of production. This is in line with the findings of Akpoko (2001) who found that majority of the farmers were of middle age in a study of factors associated with adoption of recommended poultry management practices in Kaduna State, Nigeria. The results further shows that about 37 percent of the respondents were in the age range of 31–40 years while 15 percent of them were in the age range of 21–30 years. Only 2% of the respondents were above 51 years. The mean age of the respondents was 39.This implies that the productive age groups in the study area are actively involved in DTMA production and still have energy to cope with the rigours of maize production.

Table 5.1.1: Age of respondents

Age (years)	**Frequency**	**Percentage**	**Mean**
21 – 30	42	15.2	39
31 – 40	102	37.0	
41 – 50	126	45.6	
51 – 60	6	2.2	
Total	**276**	**100**	

Minimum =21

Maximum =60

StD = 11.9

5.1.2 Household size

On the issue of household, it was discovered that about 41 percent and 35 percent of the respondents respectively had between 16-20 and 21 above numbers of people in their family (Table 5.1.2). This implies that the respondents had large household size which could be use as source of labour for DTMA production. The mean of the household size was 10. One can deduce from these findings that the number of children in the various families is now increasing, unlike what was obtainable in the past. However, having larger children in a family tends to influence adoption. This is in line with the findings of Adeniji (2007), who found that maize production was labour-intensive and the household size positively related to the adoption of maize production in Katsina State. This result is further supported by Banji and Fuluso (1998) who asserted that the aim of technology adoption is among others, to increase the scale of production and productivity of labour.

Table 5.1.2: Distribution of farmers according to household size

Household size	**Frequency**	**Percentage**	**Mean**
1-5	12	4.3	10
6-10	22	8.0	
11-15	34	12.3	
16-20	112	40.6	
21 above	96	34.8	
Total	**276**	**100.00**	

Minimum =1

Maximum =21

StD = 5.4

5.1.3 Level of education

The levels of education of the respondents as presented in Table 5.1.3 revealed that about 46 percent of the respondents had Koranic education while 18 percent, 13 percent and 10 percent and 4 percent of them had secondary, adult, Primary and Tertiary

education, respectively while 7 percent of them had no education at all. The implication of this finding is that farmers with this level of education may not be able to read and understand the importance of adopting these maize varieties and the technicalities involved in its production. This finding is in line with the findings of Yusuf (2009), who found that in Kaduna State, the highest level of education of the respondents is Islamic education. This could be due to the fact that Koranic education is highly emphasized in the studied communities of Katsina State. The implication of this finding is that the respondents were responsive to positive change since 12 percent of them had adult education. Njoku, (1991) observed that years of formal education had positive influence on adoption of innovations. This may suggest that most of the respondents (90%) are potential adopters of innovations that improve productivity.

Table 5.1.3: Distribution of farmers according to level of education

Level of Education	**Frequency**	**Percentage**
No formal education	20	7.2
Adult education	34	12.3
Primary School	128	46.4
Vocational education	29	10.5
Secondary School	52	18.8
Tertiary education	13	4.8
Total	**276**	**100.00**

5.1.4 DTMA Farming Experience

The study also investigated the DTMA years of farming experience among respondents the findings revealed that 52 percent of the respondents had between 1-5 years of DTMA farming experience, 23 percent and 22 percent of the respondents had between 6-10 years and 11-15 years of experience in DTMA production respectively. The mean DTMA farming experience was 6.8 years. The high mean years of DTMA experience suggests that the respondents would be able to take sound decision as regards to

adoption of DTMA varieties, having experience both local and improved varieties this long.It means there was a strong basis for confidence in farmers'adoption of the DTMA giving their level of experience in maize farming. The confidence people make to adopt an innovation comes as a result of experience. Experience here will help the farmer to decide if he is to accept or reject DTMA base on theperformance of the DTMA compared with other varieties around.

Table 5.1.4: Distribution of respondents according to DTMA farming experience (n = 276)

Farming experience	Frequency	Percentage	Mean
1-5	143	51.8	10.3
6-10	64	22.1	
11-15	61	19.0	
16-20	8	9.4	

Minimum =1

Maximum =20

StD = 2.4

5.1.5 DTMA farm Size:

On availability of land or farm size devoted to DTMA it was noted that those with DTMA farm sizes between 0.1-5.4 hectares of land were about 88percent, those with farm size of between 5.5-10.4 hectares accounted for about 6.2 percent while about 4 percent had farm size of about 15.5-20.4 hectares, those within 20.5 and above hectares of farm size were 2.2 percent. This shows that majority of the farmers are subsistence producers with average farm size of about 2.7 hectares. This implies that maize production in the study area was engaged by small-scale farmers. This finding is in agreement with that of Olayide *et al.* (1980); Ojo (2009), who classified farm-size owners of 0.1 hectare to 5.9 hectares as small scale farmers.

Table 5.1.5: Distribution of respondents according to land devoted to DTMA (n =276)

Farm size	Frequency	Percentage	Mean
0.01-4.99	242	87.6	2.7
5.00-9.99	17	6.2	
10.00-14.99	11	4.0	
15.00-19.99	0	0.0	
20.5-25.4	6	2.2	

Minimum =0.1

Maximum =25

StD = 2.2

5.1.6 Access to credit

In Table 5.1.6 and 5.1.7, it was found that majority (77.9%) of the respondents had no access to credit, while most of those who had access to credit (30%) obtain credit from their spouses. Other sources of credit include, friends/relatives (23%), local money lenders (18%), cooperatives (23%), and banks (7%). This indicates that the respondents lacked enough capital to adopt the DTMA varieties, since only 33% of the respondents received financial assistance. The worst is that banks which are in position to provide more funds (loan) to the respondents, recorded the least (7%) sources of fund. The result shows that the mean credit need of the respondents was ₦69,208, while about half (49%) of them needed the mean credit range of ₦81,000. Similarly, 28 percent of the respondents needed the mean credit range of ₦60,000. Despite the respondents credit need, Table 5.6 shows that about 55 percent of them had no access to credit at all for their maizeproduction. The forty five percent of the respondents that had access to credit received only a mean credit of ₦18, 451. The implication of this finding is that there is a need gap of about ₦50, 747. This shortfall could adversely affect the farmers' productivity

Table 5.1.6: Distribution of respondents according to access to credit facilities

Access to credit	Frequency	Percentage
Accessible	61	22.1
Not accessible	215	77.9
Total	276	100

Items	Mean range	Frequency	Percentage
Credit need of the respondents (144)			
50,000 -70,000	60,000	40	27.78
71,000 – 91,000	81,000	70	48.61
92,000-112,000	102,000	14	9.22
113 -133,000	123,000	12	8.33
134,000 – 154,000	144,000	8	5.56

Table 5.1.7: Distribution of respondents according to number of recipients and amount of credit received (n=61)

Sources of credit	Frequency	Percentage
Husband	18	29.5
Friends/Relatives	14	23.0
Local Money Lenders	11	18.0
Cooperatives	14	23.0
Banks	4	6.5
Amount of credit received (₦)		
10,000-24,000	36	59.0
25,000-39000	14	23.0
40,000-54000	8	13.1
>54000	3	4.9

5.1.8 Extension contact

The Findings (Table 5.1.8) revealed that about 68 percent of the respondents had never come in contact with extension agents during the cropping year while about 31% of the respondents have had contacts with extension agents from the State Agricultural Development Project (ADP), This signifies that there was poor extension services in the area, which might have resulted in the inefficient use of the improved technologies. The possible reason for non-contact on the part of the 68 percent of the respondents could be

as a result of the location of their communities from the ADP zonal headquarters, and the ineffectiveness of the extension agents in disseminating information. This finding is similar to that of Adedoyin and Patrick-Ngoyi (1996) who reported that farmers lacked access to extension workers which prompted them to request for provision of extension services which can be more responsive to their needs by private organization and religious bodies. Similarly, Chery *et al.* (2000) found that the adoption of new technologies is often influenced by the frequency of the farmer's contact with extension agents. Chikwendu *et al*. (1996) stressed the importance of extension agents as a source of agricultural information dissemination to farmers. The relationship between agricultural extension agent and the farmer could be an important determinant in the adoption and sustenance of improved farm practices such as recommended DTMA varieties.

Table 5.1.8: Distribution of respondents based on their extension contact and number of visit

Items	Frequency	Percentage
Extension contact		
Contact	87	31.5
No contact	189	68.5
Total	276	100.00
Number of visits (n =87)		
Once	37	42.5
Twice	41	47.1
Thrice	5	5.8
Four times	4	4.6

5.1.9 Membership of social organizations

Table 5.1.9 shows, that 18.8 percent of the respondents belonged to cooperative societies, and majority of the farmers, 81.2 percent did not belong to any farmers' cooperative society. Farmers' cooperative societies are expected to serve as a link between the farmers and other institutions that serve farming communities, such as

financial institutions, research centers, input manufacturers and suppliers, processors of farm products and marketing agencies. Members of an organization can benefit from receiving loan, information, and mutual help from their association

Table 5.1.9: Distribution of respondents according to membership of social organizations

Membership	Frequency	Percentage
Member	52	18.8
Non member	224	81.2
Total	**276**	**100.00**

5.1.10 Relative advantage

Result in Table 5.1.10 shows the distribution of the respondents' weighted response of their perceptions of DTMA varieties. The result indicates that option (a) statement ''the DTMA varieties yield more than the traditional maize varieties' has a high mean score of 3.56. The option (b) statement ''DTMA varieties has high market price as compared with the traditional maize varieties'' has also a high mean score of 3.78. While option (c) statement ''the DTMA varieties has high tolerant to diseases and pest as compared with traditional maize varieties '' reflected the the perception score of 3.43. The perception score above the midpoint of 2.5 indicate a framers perception of the relative advantage of the DTMA varieties to be better than the traditional varieties the produced. The high mean score of all the statements indicates a high relative advantage. This finding lends support to earlier findings of Olaniyan (1998) who posited that relative advantage had a strong influence on adoption of improved cassava varieties among women farmers in Oyo State. Ekong (2010) emphasized that though each innovation has its advantage(s), unless a people perceive this advantage to be relatively superior to their current practice, the innovation will not be adopted.

Table 5.1.10: Distribution of Respondents' Perception of the Relative Advantage of DTMA varieties

Statement	**Option**	**core (x)**	**Frequency**	**Weighted score (fx)**
The DTMA yield more than the traditional maize varieties	Strongly agree	5	8	40
	Agree	4	208	832
	Uncertain	3	5	86
	Disagree	2	43	15
	Strongly disagree	1	12	12
			276	**985**
Weighted mean score (x) =				985/276=3.56
DTMA varieties has high market price as compared with the traditional varieties	Strongly agree	5	32	160
	Agree	4	201	804
	Uncertain	3	3	9
	Disagree	2	33	66
	Strongly disagree	1	7	7
			276	**1046**
Weighted mean score (x) =				1046/276=3.78
DTMA varieties has high tolerant to diseases and pest as compared with traditional maize varieties	Strongly agree	5	12	60
	Agree	4	153	612
	Uncertain	3	67	201
	Disagree	2	32	64
	Strongly disagree	1	12	12
Total			**276**	**949**
Weighted mean score (x) =				949/276=3.43

5.1.11 Compatibility

Compatibility has mean response of 2.53. The low mean score implies that the DTMA are not all that compatible with the traditional varieties. This could be as a result of the complain that the DTMA varieties were perceived to have low flour retention when dehulled before milling and that the taste of DTMA varieties are not as desirably sweet

as the traditional varieties. This could be the reason why only 10% of the respondents adopted Sammaz 26.

Table 5.1.11: Distribution of Respondents' Perception of the Compatibility of DTMA Varieties

Statement	Option	Score (x)	Frequency	Weighted score (fx)
The DTMA varieties are compatible with your norms and existing culture	Strongly agree	5	127	254
	Agree	4	53	212
	Uncertain	3	46	138
	Disagree	2	45	90
	Strongly disagree	1	5	5
Total			**276**	**699**
Weighted score (x)				=699/276=2.53

5.1.12 Complexity

The statement in Table 5.1.12 which states that "DTMA varieties are not complex" had mean response of 3.83. The result indicates that the DTMA varieties were easy to produce in of terms its recommended practices. No much training is required to use to produce the varieties.

Table 5.1.12: Distribution of Respondents' Perception of the Complexity of the DTMA varieties

Statement	Option	Score (x)	Frequency	Weighted score (fx)
DTMA varieties are not complex	Strongly agree	5	24	120
	Agree	4	207	828
	Uncertain	3	13	39
	Disagree	2	26	52
	Strongly disagree	1	20	20
Total			**276**	**1059**
Weighted score (x)=				1059/276=3.83

5.2 Level of Awareness and Adoption of DTMA Maize Varieties

The third objective of the study was to determine the levels of farmers' awareness and adoption of the nine DTMA varieties.

5.2.1 Level of awareness

Figure 3 shows the levels of respondent's awareness of the DTMA varieties in the study area. Figure 5.2.1 shows that most of the farmers were aware of some of the DTMA varieties. Out of the 276 farmers studied, 60 percent were aware of all the nine DTMA varieties. The results showed that 96 percent, 95 percent, 89 percent, and 78 percent of the respondents were aware of Sammaz 18, Sammaz 22, sammaz 24 and sammaz 23 DTMA varieties respectively. Similarly, the DTMA varieties the respondents were least aware of were Sammaz 25, Sammaz 27 and Sammaz 26. The result suggests that there was relatively low awareness of Sammaz 25, Sammaz 27 and Sammaz 26 (Figure 2). Considering the fact that diffusion of agricultural innovations demonstrates that awareness of a technology is a necessary step in the adoption-decision process. Farmers' adequate awareness of the DTMA varieties must be ensured through a deliberate information dissemination effort.

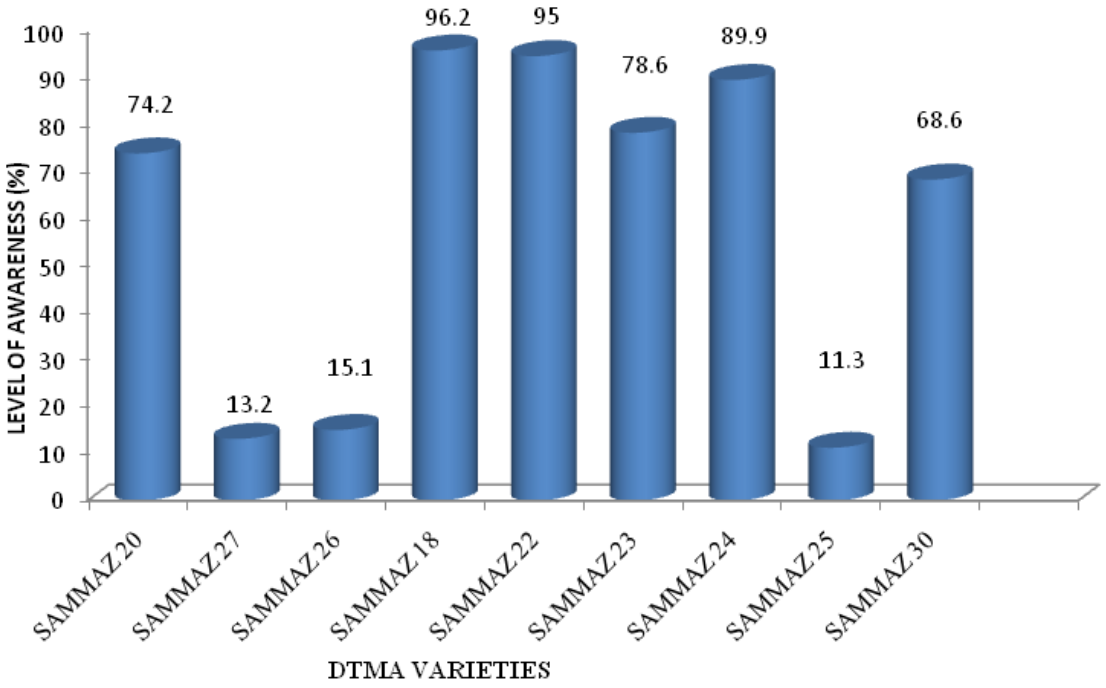


Figure 5.2.1: Distribution of respondents according to levels of awareness

5.2.2 Sources of awareness

Sources of awareness on DTMA varieties were identified and the results are as presented in Table 5.2.2. The table presents a summary of the finding on the sources of awareness. The greatest percentage (37%) mentioned radio as major source of awareness followed by friends and relatives (26%) and extension agents (16%) of the respondents respectively. Agro-dealers (8%), television (7%), field days (3%) and demonstration (1%) were the least sources of awareness of DTMA varieties by the respondents. Only about 0.2% indicated the use of agricultural extension bulletin as a source of awareness of the DTMA varieties by the respondents.

Based on the evidences presented, it is concluded that farmers used or indicated a number of authentic sources of information which they first obtained information about the maize varieties. Radio, Extension workers, friends and relatives and agricultural shows serve as greater sources of awareness than the newspapers, demonstrations and

bulletins as sources of extension information. In effect the use of credible sources of information to create awareness about DTMA varieties is desirable for adoption. Adoption research has found that, acceptance of new ideas are associated with the use of a credible information source. This finding agrees with that of Alao (1971).

Table 5.2.2: Distribution of respondents according sources of awareness

Sources of extension message	Frequency*	Percentage	Ranking
Radio	132	36.6	1st
Friends/relatives	94	26.2	2nd
Extension agents	58	16.1	3rd
Agro-dealers	29	8.1	4th
TV	25	6.9	5th
Field day	11	3.1	6th
Newspaper	6	1.7	7th
Demonstration	4	1.1	8th
Extension bulletins	1	0.2	9th

*Responses more than sample size due to multiple responses

5.3 Adoption

Figure 5.3 shows the distribution of farmers by level of adoption of DTMA varieties by the respondents. The result shows that 64 percent, 62 percent and 60 percent of the respondents had adopted Sammaz 18, Sammaz 22 and Sammaz 23 DTMA varieties respectively. The least adopted DTMA varieties by the respondents were Smmaz 26, 25 and 27.

The higher adoption rates of Sammaz 18 could be because the variety has high tillering and is an early maturing variety that can be grown in drought prone areas. This variety may give a higher output of maize due to its tillering effects (NAERLS, 2009).

The reason for the high adoption rates of Sammaz 22 may be due to the findings that it is highly tolerant to drought and low nitrogen level. The variety matures in 100-120 days and it is hybrid (NAERLS, 2009).

Sammaz 23 had high adoption rates due to the fact that the variety is fertilizer responsive and is early maturing.

The lower adoption rate for Sammaz 10 could be because the variety can be easily attack by storage pest and has light weight (in terms of marketing).

The lower adoption rate for Sammaz 25 and 27 is that Sammaz 25 needs more fertilizer and small grain while Sammaz 27 is late maturing and require good rainfall (NAERLS, 2009).

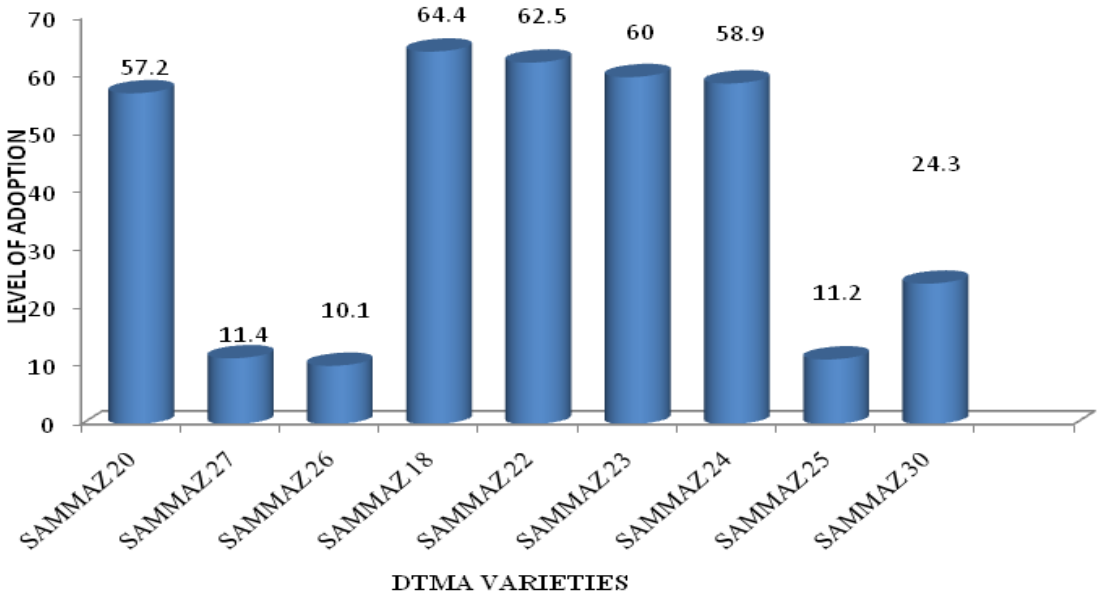


Figure 5.3: Distribution of respondents according to levels of technology adoption

5.4 The Influence of Socio-economic, Institutional and Technological Variables on Farmers' Adoption of DTMA Varieties

Objective v: To determine factors influencing farmers' adoption of DTMA maize varieties in the study area, Tobit regression analysis was used to analyze the socio-economic variables, institutional and technological variables influencing adoption of DTMA technologies as presented in the model (figure 1). The result as shown in Table 5.4 indicates that farmers' age (0.33125), household size (0.33823), education

(0.16055) DTMA farming experience (0.98614) and DTMA farm size documents (0.22760) were positively and significantly related to adoption. It was found also that extension contact (0.83050) membership to cooperative (0.63773) complexity (1.19020) and relative advantage (0.55714) significantly influenced adoption.

5.4.1 Socio-economic variables

Hypothesis I: The first hypothesis was that the farmers' socio –economic, institutional and technological characteristics would not have influence on adoption of DTMA varieties. The result of multiple regression analysis in Table 5.4 shows that age of the respondents had a positive coefficient (0.33125) and significant.Age was positive (0.3312) and significantly influenced adoption of DTMA varieties. This indicates that the older the respondent, the greater the probability for adoption of DTMA by the respondents. This is contrary to the apriori expectation of a negative coefficient for age. The reason may be that older farmers possess longer experience in farming and would have known the profitability associated with the adoption of DTMA varieties and would therefore readily accept any useful innovations for expanding production. This result is in agreement with Ezeh and Unamma's contention (1989) to the effect that farming experience and skill are largely determined by age of the farmer.

The result further showed a positive coefficient (0.3382) of household size of the respondents, which implies that the household size had positive influence on the adoption of DTMA varieties. This finding corroborates with Adesina and Baidu-Forson (2009), who found that household size, had a positive contribution to the adoption of recommended practices.

The education variable had positive coefficient (0.1605) and significantly influenced adoption of DTMA varieties at 5 percent level of probability. The implication of this is that maize farmers with more educationwould adopt more of the DTMA varieties than

those with less education. The reason is that better educated farmers are significantly more prone to accept new techniques in agriculture than less educated ones. This findingis in agreement with that of Caswell *et al.* (2001) that education creates a favourable mental attitude for the acceptance of new practices.

In a similar trend, the farming experience had a positive coefficient (0.9861) which significantly influences the adoption of DTMA varieties at 5 percent level of probability.

The positive coefficient (0.2278) of the farm size of the respondents shows that farm size positively influenced the adoption of the DTMA varieties. This finding supported the findings of Ekong (2005); Ahmadu (2009), who they found the size of farm land to be positively and significantly influence the adoption of an innovation.

5.4.2 Institutional variables

Access to extension service positively (0.8305) influence adoption at 10% level of probability. This indicates that the more the number of extension visits, the greater the adoptions of DTMA varieties. Access to extension is critical in promoting adoption of modern agricultural production technologies. Constant meeting between the extension personnel and the farmer would enlighten the latter and greater awareness for the potential gains of improved agricultural innovations (Obeta and Nwagbo, 1991).

The insignificant relationship (0.3088) between credit and adoption could be attributed to the difficulties small scale farmers face in other to source funds, especially from financial institutions. This was in agreement with Hassan (1992) who posited that small scale farmers who don't have good collateral are not usually considered by formal credit institutions because individual farmers do not patronize banks rather through cooperatives. It was expected that adoption of technologies and access to credit would

be significantly related to adoption of DTMA varieties.This indicates that credit positively influence the adoption of DTMA varieties, though, credit was not adequate because most of the respondents did not have access to credit (Table 5.4).This finding is in line with Akpoko and Yiljep (2001); Benjamin (2010), they found that credit had a positive but insignificant influence on adoption of recommended practices.

In a similar trend, the regression coefficient (0.6377) of the respondents' membership of social organization was found to contribute positively and significantly to adoption of DTMA varieties. This implies that membership of a social organization was important in inducing farmers to adopt the DTMA varieties. This finding is in line with Salawu (2007), who found that social organizations are made up of different categories of adopters. As innovators and early adopters interact with late majority and others, it would influence the outlook of other categories to adopt. It also agree with finding of Ojo (2009), who found that social organizations serve as forum through which members could exchange ideas, learn new farm practices and have access to information.

5.4.3 Technological variables

The regression analysis shows that Complexity (1.9902) was significantly and positively correlated with adoption of DTMA varieties at 5% level of significance.

This implies that the DTMA varieties do not require too much technicalities to operate and use.

The regression result in Table 5.4 reveals that relative advantage (0.5571) was positively and significantly related to the adoption of DTMA varieties. The significant relationship between adoption and relative advantage could be attributed to the various advantages of high yield, drought tolerant, earliness to harvest and above all gives more income due to market demand.

Compatibility was not significantly (0.4809) related to adoption. This could be as a result of the complain that the DTMA varieties were perceived to have low flour retention when dehulled before milling and that the taste of DTMA varieties are not as desirably sweet as the traditional varieties. The implication is that the some of the DTMA varietiesespecially sammaz 30 and sammaz 22 had those characteristic when compared with the traditional maize varieties and this can hinder adoption.

The result of the Tobit regression analysis shows the coefficient of multiple determinations, the R^2 estimates value of 57.7% of the sampled variation in the factors that influence of DTMA varieties in the study area is explained by respondents, Age, level of education, household size, cooperative membership and extension services. This implies that about 42.3 percent of the sampled variation in the factors that influence farmers' adoption of DTMA varieties is explained by other variables that may not have been included in the regression analysis. Hence the null hypothesis which states that there is no significant relationship between the socio-economic, institutional, and technological characteristics of farmers and adoption of DTMA varieties is therefore rejected and concluded that there is significant influence between the socio-economic, institutional and technological characteristics and farmers and adoption of DTMA varieties in the study area.

Table 5.4: The Influence of Socio-economic and Institutional and Technological Variables on Farmers Adoption of DTMA

Variables	Coefficient	Standard Error	t. ratio
Constant	5..3494	1.3798	3.8769
Age	0.33125	.15846	2.0904***
Household size	0.33823	.14605	2.3158***
Education	0.16055	.71957	2.2312***
Farming experience	0.98614	4.8878	2.0176***
Farm size	0.22780	.10129	2.2336***
Credit	0.30884	.21228	1.4549
Extension contact	0.83050	.70293	1.1815*
Cooperative groups	0.63773	.26025	2.4505***
Compatibility	0.48095	.16400	1.7326
Relative advantage	0.55714	.29602	1.8823***
Complexity	1.99020	0.8887	2.1890***

R^2 =57.7. ***P<0.01,**P<0.05 and *P<0.10

5.5 Effects of Adoption of DTMA Varieties on Respondents' Yield, Income and Level of Living

5.5.1 Yield

Yield is the quantity of crop harvested by farmers on a given piece of land. Invariably yield level is a measure of income level of farmer. The higher the yield level, the higher the income and consequently the level of living which in turns influences adoption decisions.

DTMA varieties are those that require adoption by farmers for which yield is one of the key determining factor. The result in Table 5.5.1 shows that respondents with very low yield level (below 1000kg/ha were about 43 percent, those with medium yield level (above 1000-1500kgs/ha) were about 34 percent, those within the output brackets above 1500-2000kgs/ha (moderate) were about 12 percent. Those with high yield level (above 2000kgs/ha were about 10 percent. It is noteworthy that respondents with the yield level below 2000kgs/ha were about 62 percent representing a two-third of the respondents.

This indicates that majority of the respondents were of low yield levels. This implies that due to their low yield levels, therefore the adoption of certain costly DTMA varieties will be low. This corroborates Ekong (2010) report that most Nigeria farmers are poor resource-base to tap, exploit, develop and use available/ potential production resources to become rich.

Table 5.5.1: Distribution of respondents according to levels of yield (kgs)

Yield level (Kgs)	**Frequency**	**Percentage**
<1000	120	43.5
>1000-2000	95	34.4
>2000-3000	34	12.3
>3000	27	9.8
Total	**276**	**100**

Mean =947.6

Min = 560

Max = 3000

Std = 1145.7

5.5.2 Income

Farm income of an individual farmer influences his social position, the people with whom he interacts, the type of interaction, the problems and dilemmas that he encounters and the means that are available to him to solve such problems. The frequency distribution of respondent according to their incomes is presented in Table 5.18. As revealed in Table 5.5.2, majority of the surveyed farmers (80.8 percent) were in the low income group. While 10.1 percent of the respondents were in the medium income group, only 9.1 percent were in the high income socio-economic group. This implies that adoption of DTMA varieties is imperative to increase income generation of adopters.

Table 5.5.2: Distribution of respondents according to levels of income

Income level	Frequency	Percentage
100000-199000	223	80.8
200000-399000	28	10.1
Over 400000	25	9.1
Total	**276**	**100**

Mean = 172028
Min = 100000
Max = 400000
Std = 171584

5.5.3 Level of living

As revealed in Table 5.5.3, majority of the surveyed farmers (81.5 percent) were in the low level of living group. While a substantial 13.8 percent of the respondents were in the medium socio-economic group, only 4.7 percent were in the high socio-economic group. This implies that adoption of DTMA varieties is imperative to change level of living of adopters

Table 5.5.3: Distribution of farmers according to levels of living

Level of living	Frequency	Percentage
100000-199000	225	81.5
200000-399000	38	13.8
Over 400000	13	4.7
Total	**276**	**100**

Mean = 172028 ; Max = 400000; Min = 100000
Std = 191258

5.5.4 Hypotheses Testing

5.5.4.1 Adoption and level of yield

To test the hypothesis which states that there is no significant effect of adoption of DTMA varieties on farmers yield, the analysis was further put to statistical test to verify if there was any significant effect. The ANOVA result in Table 5.5.4.1 revealed that the calculated *f*- value for yield (4.070) was significantly higher than the *f* -value set at 0.1 level of probability. Since the *f*-value calculated for the variables and adoption lies

above the tabulated value; it implies that there was a significant effect between adoption and yield. Therefore, the null hypothesis which states that there is no significant difference between adoption of DTMA and farmers yield, is rejected and the alternative accepted that there is significant effect between adoption of DTMA varieties and farmers output. Meaning that adoption of DTMA resulted to increase farmers'maize yield

Table 5.5.4.1: ANOVA results showing DTMA adoption and level of yield

	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	9226418.033	2	4613209.016	4.070	109
Within Groups	4533824.466	4	1133456.117		
Total	13760242.499	6			

5.5.4.2 Adoption and level of income

The ANOVA result in Table 5.5.4.2 revealed that the calculated *f*- value for level of income (.102) was higher than the *f* -value set at 0.1 level of probability. Since the *f*-value calculated for the variables and adoption lies above the tabulated value; it implies that there was a significant effect between adoption and farmers income level. Therefore, the hypothesis which states that there is no significant difference between adoption of DTMA varieties and farmers' income is therefore rejected and the alternative accepted that there is significant effects between adoption of DTMA maize varieties and farmers level of income.

Table 5.5.4.2: ANOVA results showing DTMA adoption and level of income

	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Between Groups	101229655.893	2	50614827.946	.102	.988
Within Groups	17222656491.981	4	4305664122.995		
Total	17323886147.874	6			

5.5.4.3 Adoption and level of living

The ANOVA result in Table 5.5.4.3 revealed that the calculated *f*- value for level of living (0.878) was significantly higher than the *f* -value set at 0.1 level of probability. Since the *f*-value calculated for the variables and adoption lies above the tabulated value; it implies that there was a significant effect between adoption and level of living. Therefore, the hypothesis which states that there is no significant effect between adoption of DTMA varieties and farmers' level of living is rejected and the alternative accepted that there is significant effects between adoption of DTMA varieties and farmers level of living.

Table 5.5.4.3: ANOVA results showing DTMA adoption and level of living

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	381188623390.827	2	190594311695.413	.878	.483
Within Groups	868008210066.653	4	217002052516.663		
Total	1249196833457.48	6			

5.6 Constraints to adoption of DTMA varieties

The study examined the constraints to the adoption of DTMA varieties in the study area.The constraints are as shown in Table 5.6. Topping the list of the constraints faced by respondents in adopting the DTMA varieties was that a number of farmers (32%) do not have access to source of DTMA seeds due to unavailability of the seeds in the vicinity. The use of improved varieties is the means through which a nation can achieve the expected increase and be self-sufficient in maize production within a short period of time (Oyekale, 2006). This implies that farmers' access to improved seeds is crucial to maize farmers in order to increase maize production in Nigeria. Idrisa *et al*. (2012) in their study on analysis of awareness to adaptation to climate change among farmers in the Sahel savannah agro-ecological zone of Borno State of Nigeria found availability of improved seeds as constraint to the adoption of improved farming technologies.

It is noteworthy that 22 percent of the farmers reported costly nature of some of the varieties. This could be linked to unavailability of DTMA varieties to the respondents. There were just a few of the respondents who could afford the varieties thereby making it difficult for the respondents to afford. For this reason, respondents were not able to use the different varieties.

As has repeatedly been pointed out that awareness of a technology is basic to the adoption process, a number of respondents (14.1%) mentioned lack of awareness of some of the DTMA varieties as a constraint militating against their adoption of climate change maize production technologies. Arokoyo (1981) in his study on the diffusion and adoption of recommended agricultural practices among farmers in the Northern States of Nigeria found that, lack of awareness was one of the factors hindering the adoption of the recommended practices.

It is interesting to note, however, that farmers complained of inadequate fertilizers (12.1%), even when they cannot use enough inorganic fertilizer to realize the potential of their maize output because of poor soil conditions. Low soil fertility is one of the main problems in Katsina State of Nigeria, making it important for maize farmers to adopt DTMA maize varieties that are less dependent on organic fertilizers.

Specifically Table 5.23 revealed that poor soil fertility condition is another constraint in DTMA adoption (9.8%) in the study area. This is probably so, because Bala and Goyal (1999) reported that soils of the North-West agro-ecological zone are mostly of arid type characterized by low level of organic matter, slightly acidic to alkaline reactions, weak to moderate profile development and low biological activity. They argued that these pave way to desert encroachment. According to them, over 5000square kilometers in Sokoto, Kebbi and Katsina States lie in this critical belt of vast expanse of land with

little or no tree growth subjected to dust and shifting sands making this zone vulnerable to drought. The northern-most part of the area studied fall within this drought proned areas. These problems make the production of maize constantly on the verge of instability and therefore sensitive to climate change.

Respondents also reported prolonged drought as another most important constraint during the 2013-2014 production season. Drought was reported by about 3.3 percent of the respondents to be damaging to maize plants when occurring after planting or during flowering. In its report IPCC (2007) indicated that there has been low rain, and this variability in climatic conditions adversely affected maize yield in the northern part of Nigeria.

Therefore, the most important constraints to adoption of DTMA varieties were (unavailability costly nature of DTMA, unawareness of seed types) and the least important constraints were (poor soil condition, pests and diseases, drought occurences).

Table 5.6: Distribution of respondents by constraints to adoption of DTMA varieties

Constraints	**Frequency of responses***	**Percentage**	**Ranking**
Unavailable DTMA seeds	98	32.0	1st
High seed cost	68	22.2	2nd
Un aware of seed types	43	14.1	3rd
Inadequate fertilizers	37	12.1	4th
Poor soil condition	30	9.8	5th
Pests and diseases	20	6.5	6th
Drought occurence	10	3.3	7th

*Frequency more than sample size due to multiple responses

CHAPTER SIX

6.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary

The purpose of the study was to examine the adoption of DTMA varieties by maize farmers in Katsina State, Nigeria. Identification of the factors affecting adoption of agricultural production technologies are important for policy makers, researchers and organizations involved in shaping agricultural development.

The study covered six out of 34 LGAs of Katsina State. Data were collected with the use of structured questionnaire administered to purposively selected farmers with the help of trained 6 village extension agents from KTARDA. The collected data were coded and entered on micro-soft excel sheets and transferred to the Statistical Package for Social Sciences (SPSS) for computer analysis. The computer output included:

i. descriptive analysis of the coded data
ii. one-way analysis of variance (ANOVA) to test for significance effects of adoption of maize production technologies on farmers yield , income and level of living. The significance level was set at 0.5 percent level of probability to determine level of effects of adoption on the three pre-determined variables.
iii. tobit regression analysis to the determine strength of influence of adoption (dependent variable) and the independent variables of the study set at 5 percent level of probability.

The results of socio-economic characterstics of respondents show that about 46 percent of the respondents were within the age range of below 41–50 years. The mean of the household size was 10. Majority (46%) of the respondents had Koranic education. The mean DTMA experience by the respondents was 10.3 years, with mean farm sizes of

about 2.7 hectares of DTMA farm land. Majority (77.9%) of the respondents had no access to credit. Findings revealed that 87 percent of the respondents had never come in contact with extension agents during the cropping year. Only 18.8 percent of the respondents belonged to cooperative societies.

Respondents perceived that DTMA varieties have high market price as compared with the traditional maize varieties with a mean score of 3.78. Compatibility had a mean response of 2.53.

The result showed that respondents with very low output level (below 1000kg/ha were about 43 percent while those with high output level (above 2000kgs/ha were about 10 percent of the respondents. Majority of the respondents (81.8 percent) were in the low income group while 10.1 percent of the respondents were in the high income group.

The results showed that 96 percent, 95 percent, 89 percent, and 78 percent of the respondents were aware of Sammaz 18, Sammaz 22, sammaz 24 and sammaz 23 DTMA varieties respectively. Similarly, the DTMA varieties the respondents were least aware of were sammaz 25 (11.3%), Sammaz 27 (13.2%) and Sammaz 26 (15.1%). A majority of the surveyed farmers (81.5%) were in the low level group. While a substantial 13.8 percent of the respondents were in the medium socio-economic group, only 4.7 percent were in the high socio-economic group.

A percentage (37%) mentioned radio as major source of awareness followed by friends and relatives (26%) and extension agents (16%) of the respondents respectively. Agro-dealers (8%), television (7%), field days (3%) and demonstration (1%) were the least sources of awareness of DTMA varieties by the respondents.

The result showed that 64 percent, 62 percent and 60 percent of the respondents had adopted Sammaz 18, Sammaz 22 and Sammaz 23 DTMA varieties respectively. The

least adopted DTMA varieties by the respondents were Sammaz 26 (10%), 25 (11.2) and 27 (11.4).

The result of factors influencing adoption of DTMA varieties indicates that farmer's age, household size, education DTMA farming experience and DTMA farm size documents were positively and significantly related to adoption. It was found also that extension contact, membership of cooperative, complexity and relative advantage, significantly influenced adoption.

The major constraints affecting farmers to adopt the DTMA varieties include: unavailability of the seeds, high cost of DTMA, unavailability of the varieties. The least constraints were: pests and diseases (6.5%), drought (3.3%) The constraints given by the maize farmers seem to be congruent.

6.2 Conclusions

Based on the findings of this study the following conclusions were made. Respondents mean DTMA farming experience was 8 years, a relatively low proportion (54.2) of the respondents seemed to be aware of the DTMA varieties and radio was the major source of awareness of the DTMA varieties it was found that sammaz 25, 26 and 27 had the lowest adoption rates. The also study found that, farm size and farming experience did not significantly determine adoption. However, it was concluded that age, education, household size, information sources, extension visits, membership to social organizations, complexity, compatibility and relative advantage significantly influenced adoption of DTMA.The major constraints to adoption of DTMA varieties were unavailability of DTMA, high costs of the DTMA, and insufficient awareness of the varieties.

6.3 Recommendations

Based on the findings of this study, the following recommendations were made in order to enhance faster adoption of DTMA varieties in the study area.

i. Famers maize output was low probably due to high effects of increased pest and diseases and drought. High yielding drought tolerant varieties could be massively deployed to drought pronned areas. This would go a long way in improving maize production failure in the study area.

ii. Levels of awareness and adoption for DTMA were relatively low. It is therefore recommended that information constraints by agricultural extension/information dissemination services in the State require improvements in quality and extent of coverage, especially to reach drought proned remote areas. It is important to provide farmers in these areas with information on benefits to be obtained from the DTMA varieties. For example, radio was found to be one of the major means by which most farmers first heard information about the DTMA varieties. Therefore, if extension agents want to introduce any new agricultural technology to the farmers, radio broadcast would be the most effective means of creating initial awareness about the new innovation.

iii. Unavailability of DTMA varieties and high cost of the DTMA varieties were major constraints to adoption of DTMA varieties. Considering the North-Western Nigerian peasant farmers' economic situation, there is a definite need to provide them with both credit facilities and subsidized inputs. Seed companies, vendors, distributors, input dealers should site their sales points at the farmers reach to enable farmers purchase needed farm inputs necessary for adoption.

iv. In reality, however, maize farmers were saddled with so many maize production constraints all of which were either: socioeconomic, institutional and

technological factors. These could be ameliorated through appropriate policies and better research approaches which will be critical to the future of maize producers and of the maize industry in Nigeria. Getting appropriate feedback on farmers technologies adoption behaviuor is crucial in designing a well-tailored intervention that could result in rationalizing scarce resources required for used by stakeholders in agricultural sector of the economy to avoid misappropriation of financial resources to develop varieties that would not be adopted by the end users.

6.4 Contributions of this Study to Knowledge

The study revealed that respondents had a mean DTMA farming experience 8.3 years, Majority 88 percent of respondents were small scale who had farm sizes of between 0.1-5.4 hectares of DTMA farm land.

Majority (77.9%) of the respondents had no access to credit. About 68 percent of the respondents had never come in contact with extension agents during the cropping year. Only 18.8 percent of the respondents belonged to cooperative societies.

This research provides information about the extent of awareness (57) percent of DTMA varieties in the study area. The study revealed the highest DTMA varieties that respondents were most aware of to include sammaz 18 (92%), sammaz 22 (95%), and sammaz 24 (90%) of the respondents.

The study also revealed the highest DTMA varieties that were most adopted by the respondents were sammaz 18 (64%), 22 (62%), 23 (60%).

This study identified the effects of adoption of DTMA varieties on maize farmers' yield (4.070), income (0.102) and level living (0.878) all higher than 0.1 which indicates that

there was significant effect of adoption of DTMA varieties on farmers yield, income and level of living.

Major constraints to adoption of DTMA varieties were identified to be non-availability of DTMA varieties (32%), high seed cost (22%), and low level of awareness of DTMA varieties (14%) of the respondents.

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APPENDIX I: FARMERS' QUESTIONNAIRE

DEPARTMENT OF AGRICULTURAL ECONOMICS AND RURAL SOCIOLOGY, FACULTY OF AGRICULTURE,

AHMADU BELLO UNIVERSITY, ZARIA

Title: **Adoption of Drought Tolerant Maize for Africa (DTMA) and its Effects on Maize Farmers Livelihood in Katsina State, Nigeria**

Introduction: this questionnaire is designed to solicit for responses on **Adoption of Drought Tolerant Maize for Africa (DTMA) and its Effects on Maize Farmers Livelihood in Katsina State, Nigeria**. Your responses will be treated confidentially, as they are strictly required for academic research purposes only. Therefore, feel free to answer the questions accurately.

SECTION A: BACKGROUND INFORMATION

Tick the box (√) or complete the spaces where necessary.

Local Government Area_____Village_____Date of interview_____

SECTION B: SOCIO-ECONOMIC CHARACTERISTICS OF THE RESPONDENTS

1. Age of Farmer_____
2. Sex: Male ( ) Female ( )
3. Highest level of formal Education:

(a) No formal education_____ years
(b) Adult education _____years
(c) Primary education_____ years
(d) Secondary education_____years
(e) Tertiary education_____years
(f) Others (specify)_____years

Total number of years in formal schooling_____years

4. How long have you been farming? _____ years.
5. Total Size of your farm land: _____ha

6. Size of your total farm land devoted to maize production in the last three years

   2012 _____(ha)

   2013 _____(ha)

   2014 _____(ha)

7. Size of your total farm land devoted to DTMA in the last three years

   2012 _____(ha)

   2013 _____(ha)

   2014 _____(ha)

8. Tenureship of your farm land:

i. Inheritance _____( )

ii. Purchase,_____( )

iii. Gift, _____( )

iv. Share cropping, _____( )

v. Least, _____( )

vi. Borrow_____( )

9. How many types of land tenures are you using for agricultural production_____

   Please list them_____

10. How many types of livestock are you keeping?_____.(number)

11. What is the number of animal in each type?

   (i) Cattle_____

   (ii) Sheep_____

   (iii) Goat_____

   (iv) Poultry_____

   (v) Others_____

12. Indicate your source(s) of livelihood (i) selling cattle (ii) Selling small animals (iii) carpentry (iv) Buying and selling agricultural produce (v) Transporter (vi) Mechanic (vii) politics (viii) Trader (ix) Artisan (x) Black smith

13. Major source of income? _____

14. Other sources of income?_____

15. What was the total income you realized from farm and non-farm activities in the last farming season? (i) farm income_____₦ (ii) Non-farm income_____₦

16. What are your major sources of funding of farm activities? Please name them

_____

HOUSE CHARACTERISTICS IDENTIFIERS

17. Roofing materials of household important residence

    i) straw thatch

    ii) mud

    iii) wood/planks

    iv) iron sheet

    v) asbestos

18. Walls materials of household important residence

    i) mud bricks

    ii) cement bricks

    iii) burnt bricks

    iv) others (specify)----------

19. Floor materials of household important residence

    i) mud floor

    ii) cement floor

    iii) tiles

    iv others (specify)----------

20. Number of rooms (minus kitchen, bathroom/ latrines----------

21. Which of the following does the household important residence has (tick as appropriate)

    i) kitchen

    ii) bathroom

    iii) pit latrine

    v) sink latrine

CREDIT

22. Did you receive any credit either from formal or informal sources in the year 2014 cropping season for agricultural production? Yes ( ) No ( )

23. if yes, please indicate the amount_____₦

24. If no, please indicate why:

(i) No source of credit in vicinity_____( )

(ii) Did not look for credit_____( )

(iii) No collateral to guaranteed credit_____( )

(iv) High interest rate_____( )

(v) others (specify)_____( )

25. If yes, what was your major source of credit for farming during the last farming season?

(a) Bank_____( )

(b) cooperative_____( )

(c) friends/relations_____( )

(e) Government agencies_____( )

(f) Money lenders_____( )

(g) others (specify) _____

26. Do you belong to any social organization/group? (i) (Yes) (ii) (No)

27. If yes, name the social groups you belong to, year spent, main activity and number group meetings attended in 2014

Name of the group	Years spent in the group	Main activity of the group	Number of meetings attended
1			
2			
3			
4			

28. List the most important benefits derived from membership of the main organization/group

_____

_____

29. Assessment of benefits from organization/group

(a) Very beneficial_____( )

(b) Beneficial_____( )

(c) Fairly beneficial_____ ( )

(d) Not beneficial_____( )

30. Were you visited by any extension worker during the 2014 season? Yes ( ) No ( )

If yes

31. How many times were you visited?

(0) None at all_____( )

(a) Once in a year_____( )

(b) On quarterly_____( )

(c) Monthly_____ ( )

(d) Fortnightly_____ ( )

(e) Weekly_____ ( )

SECTION C:

LEVELSOF AWARENESS AND ADOPTION OF IMPROVED DTMA VARIETIES

32. Are you aware of different DTMA varieties in this area ? Yes ( ) No ( )

33. indicate thevarieties that you are aware of and have adopted.

Varieties	Tick only the seed you are aware	Tick only the seed you adopted
TZE comp 3		
EVDT99W STR,		
DTSR (White)		
Tllering Early DT		
MO926-1		
MO926-3		
MO826-1		
MO26-11		
LNTPX LNP-WC		

34. If no, indicate the seed(s) you have abandoned and your most important reasons for your decisions. Please tick

Varieties	Technology abandoned	Reason for abandoning*
TZE comp 3		
EVDT99W STR,		
DTSR (White)		
Tllering Early DT		
MO926-1		
MO926-3		
MO826-1		
MO26-11		
LNTPX LNP-WC		

*Provide the possible reasons for them below here

_____
_____
_____
_____

Statements indicating perception of improved seeds.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Improved maize varieties does not yield well during drought					
Improved maize varieties require much fertilizer application					
Improved maize varieties are not better than the traditional varieties					
Improved maize varieties does not yield more than local varieties					
Improved maize varieties does not mature very early.					

35. Do you also use other seeds on your farm land,? Yes ( ) No ( )

36.If yes, please list/describe them_____

_____
_____

37. Why do you use them?

_____
_____
_____
_____

38. Compare the improved DTMA with other seeds used by you

(i) **i**mproved seeds has high tolerant to diseases and pests attack than traditional (yes) (no)
(ii) Improved seeds has high yield than traditional (yes) (no)
(iii) Improved seeds has higher market price than traditional (yes) (no)

39. Farmers' sources of information about DTMA varieties

40. What are your frequent sources of information about DTMA seed varieties?

(i). Agricultural extension agent_____( )
(ii) Extension bulletin_____( )
(iii) Newspaper_____ ( )
(iv). Radio_____( )
(v) Television_____( )
(vi) Demonstration/Field day_____ __( )
(viii) Agricultural shows_____( )
(ix) Friends/relatives_____( )
(x) Agro-dealers_____( )

41. What is your first source of information on each technology?

Varieties	Sources of information									
	Ext. agent	Ext. bulletins	News papers	Radio	TV	Demo/ fieldday	Mobile phones	Agric. Shows	Friends/ relations	Agro dealers
TZE comp 3										
EVDT99W STR,										
DTSR (White)										
Tllering Early DT										
MO926-1										
MO926-3										
MO826-1										
MO26-11										
LNTPX LNP-WC										

Extension service received or benefited by farmers.

42. Do you have any seed company, selling point, centre/agency access able to you? Yes ( ) No if yes, indicate from the following centres: (i) River Basins/Dams (irrigation) ( ) (ii) Forestry/shelterbelt station/plantation (iii) wildlife parks/game reserves/zoo ( ) (iv) ADPs ( ) (v) Research institutes ( ) (vii) others ----------

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SECTION D

EFFECTS OF ADOPTION OF DTMA VARIETIES

Effect on maize output:

43. What was the output obtained as sole crop and farm size in the last three years?;

(i) 2012?_____(100kgs bag) (ii) 2013?_____(100kgs bag) (iii) 2014? _____(100kgs Bag)

44.Farm size in hectares 2012---------- 2013---------- 2014----------

45. What was the yield of maize in crop mixtures obtained in the last three years?

(i) 2012? _____(100kgs bag)(ii) 2013? _____(100kgs bag)(iii) 2014? _____(100kgs

46. What was the total yield of other crops planted in mixture with maize

_____

47. Did you observe any increase in yield of maize? Yes ( ) No ( )

If yes, please indicate the quantity of yield_____100kg bag, and by what percentage increase_____%

48. What do you think are the possible reasons for the increase? _____

49. What was the percentage contribution to farm income?_____₦

50. Did you observe any increase inincome from maize produce only in 2014? Yes, ( ) No( )

51. If yes,please indicate the amount_____₦ and by what percentage increase_____%

52. What do you think are the possible reasons for the increase in income from maize production?_____

_____

Effects of adoption of DTMA on farmers' livelihood:

53. At present, how much/ many of the following does your household owned as a result of adoption of DTMA that are usable/repairable? (: for value per unit, ask for the current value of the asset)

Asset	Qty/No.	Value/Unit	Asset	Qty/No.	Value/Unit
House (residence)			Donkey		
Stores			Oxen		
Poultry house			Animal traction plow		
Car			Tractor		
Truck			Trailer		
Motorcycle			Plows for tractor		
Bicycle			Harrow/tiller		
Wheelbarrow			Ridger		
Chaff cutter			Planter		
Radio			Boom sprayer		
TV			Knapsack sprayer		
Mobile phone			Sheller		
Pestle and motar			Generator		
Water tank			Power saw		
Water pump			Grinder		
Kane crusher			Cattle dip		

54. Do you have some other assets that you have acquired that can be attributed to the income realized from the sale of DTMA maize produce only? Yes ( ) No ( )

55. If yes, list them

Asset	Qty/Number	Value/Unit

56. Based on your observations, what do you think generally, as desirable effects brought about by the use of DTMA maize varieties?

Desirable effects	Strongly agreed	Agreed	Undecided	Disagreed	Strongly disagreed
Increased farm yield					
Increase quality of produce					
Income					
Increase income					
Increased business					
Increased assets					

57. Where the proceeds from the sales of DTMA used to build a rented house yes ( ) no( )

58. If yes what is the worth of the building----------?

59. What is the annual income on the building----------

60. Where the proceeds gotten from the sales of DTMA used to buy farm inputs for other crops, yes( ) no ( )

61. If yes what is the estimated amount?----------

62. Has there been any change in your livelihood as result of your maize production

63. If yes, in what form?

(i) more assets
(ii) more income
(iii) more output
(iv) more business
(v) more health
(vi) education to my children

64.If no why?_____

SECTION E

CONSTRAINTS IN USE/ ADOPTION OF DTMA

65.Indicate the most serious constraints you are facing in adoption of maize varieties production

(i) Small size of landholding discourage DTMA farming_____( )

(ii) Shortage of water for irrigation_____( )

(iii) High cost of land to expand area of cultivation_____( )

(iv) Unavailability of DTMA seeds in the vicinity_____( )

(v) High cost of DTMA seeds_____( )

(vi) Distance from my village to where I can buy seeds_____( )

(vii) Low market price of produce_____( )

(viii) High fertilizer demanding of DTMA_____( )

(ix) Others (specify)----------

66.In your own opinion how best do you think these problems could be tackled? ---------

Thank you!