DETERMINANTS OF INPUTS DEMAND AND ADOPTION OF GRAIN LEGUMES AND ASSOCIATED TECHNOLOGIES OF N2Africa IN KANO STATE, NIGERIA

BY

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(SPS/12/MEX/00006)

AUGUST, 2015

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A DISSERTATION SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION, FACULTY OF AGRICULTURE, BAYERO UNIVERSITY, KANO, IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE (M.SC) IN AGRICULTURAL ECONOMICS

AUGUST, 2015

DECLARATION

I hereby declare that this work is the product of my own research efforts; undertaken under the supervision of Prof. A. Suleiman and Dr. A. Mustapha and has not been presented and will not be presented elsewhere for the award of a degree in Master of Science. References made to published literature have been duly acknowledged.

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The above declaration is confirmed

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Prof. A. Suleiman Date

(Supervisor)

CERTIFICATION

This Project Entitled Determinants of Inputs Demand And Adoption of Grain Legumes And Associated Technologies of N2africa In Kano State, Nigeria by Muhammad Halliru with the Registration number SPS/12/MEX/00006 meets the regulations governing the award of Master Degree in Bayero University, Kano and approved its contribution to knowledge and literary presentation.

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This is to Certify that, this Dissertation Title " Determinants of Inputs Demand and Adoption of Grain Legumes and Associated Technologies of N2Africa in Kano-Nigeria" Prepared By HALLIRU MUHAMMAD (SPS/12/MEX/00006) Has Been Examined and Approved in Accordance With the Regulations Governing the Award of the Degree of MASTER OF SCIENCE (M.Sc) IN AGRICULTURAL ECONOMICS

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DEDICATION

This project work is dedicated to the memory of my beloved father Late Alhaji Halliru Muhammad Daura who train me from childhood to the end of his life

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LIST OF ABBREVIATIONS AND ACRONYMS

CADP	Commercial Agricultural Development Programme
FAO	Food and Agricultural Organization
FMARD	Federal Ministry of Agriculture and Rural Development
IAR	Institute of Agricultural Research
IFAD	International Fund for Agricultural Development
IITA	International Institute for Tropical Agriculture
LDCs	Less Developed Countries
MLE	Maximum Likelihood Estimate
NSS	National Seed Service
NAAE	Nigerian Association of Agricultural Economists
NCAM	National Centre for Agricultural Mechanization
NPC	National Population Commission
NPA	Non-Project Area
NCRI	National Cereal Research Institute
NSPFS	National Special Programme for Food Security
OLS	Ordinary Least Square
PA	Project Area
SSA	Sub-Saharan Africa
USAID	United State Agency for International Development
VODEP	Vegetable Oil Development Programme

ABSTRACT

The study analyzed the determinants of inputs demand and adoption of grain legumes and associated technologies of N2Africa in Kano State. Multi-stage sampling technique was used for the study. Primary data were collected using structured questionnaire. 150 farmers were sampled each from project area and non project area making a total of 300 farmers. The analytical tools employed include descriptive statistics, multiple regression, gross margin analysis and logistic regression. The results shows that farmers in project and non-project area possess element of similarity in terms of socio-economic characteristics especially gender, marital status, major source of income and land ownership. Multiple regressions for determinants of inputs revealed that annual income and farm size has positive coefficient and were statistically significant, while price of inputs and distance to inputs source has negative coefficients and were also statistically significant. The adjusted R^2 values in respect of project area were 32%, 47% and 48% for fertilizers, seeds and agrochemicals respectively. Also the corresponding adjusted R^2 values were 44%, 37% and 49% for the legume enterprises in the non project area. Logit regression result shows that household size, annual income, farming experience and educational status are the factors that influence adoption of grain legumes. Gross margin analysis revealed that legume production is profitable in both project and non-project areas but the gross revenue obtained is higher in project area. Gross margin (per hectare) in the project area was NGN126,195.45, NGN120,853.05 and NGN75,342.17 for soybean, cowpea and groundnut enterprises. In non-project area, gross margin of NGN50,027.11, NGN65,837.91 and NGN6,799.28 were obtained for soybean, cowpea and groundnut. Multiple regression for input-output relationship shows that farm size, fertilizers and seeds were statistically significant within the project area having adjusted R^2 of 77.4%, 84% and 74.9%; while 82.9%, 86.4% and 74.4% were obtained in the non project area for soybean, cowpea and groundnut. Constraints affecting input demand include high cost of fertilizers and improved seeds, lack of inoculants and late arrival of inputs while adoption of grain legumes is affected by attack of pest and diseases, drought problems and low price of output. Farmers should be encouraged to produce legume through adequate training on legumes production techniques including efficient utilization of labour and other resources as well as proper disease and pest management. There is also the need for sustainable input supply policy that will ensure availability, accessibility, affordability and timely delivery of agricultural inputs for better legume production in the study area.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Agricultural research systems are generally responsible for generating and developing innovations for increasing agricultural productivity. Technology development and transfer play a crucial role in attaining the main goal to increase agricultural output, productivity and farmers’ income. Adoption of recommended technologies implies that technologies are relevant to the farmers' circumstances. If farmers become aware of technologies or modifications in the use of resources that are relevant to their circumstances and can improve their farm production and thus their welfare, they will most likely adopt these changes (World Bank, 2011).

N2Africa is a development research introduced to Nigeria with sole objective of ensuring nitrogen fixation to African soil for increased productivity, farmers’ income and overall living standard of the smallholder farmers. The project is sponsored by Bill and Melinda foundation and is being run by Weignigen University, Netherland in collaboration with International Institute for Tropical Agriculture (IITA). The program focus on adoption of grain legumes (cowpea, soybean and groundnut) and some associated technologies specifically. These associated technologies includes the use of purchased inputs such as seeds, inoculants and fertilizers as well as other good recommended agricultural practices. These recommended practices includes seeds planting, appropriate spacing (inter and intra-row spacing) and good management among others for better productivity. (N2Africa, 2012).

It is widely accepted that increased use of purchased inputs (seeds, chemicals and fertilizers) has a critical place, alongside organic soil fertility enhancement practices. This is the technical change needed for sustained smallholder agricultural growth in Africa. However, purchased input use is very low amongst the farmers especially from Sub-Saharan Africa and has remained largely static over the last 20 years, with particularly low usage in smallholder food-crop production where constraints on expanded purchased inputs (seed and fertilizer) use exists on both the supply and demand sides. Adoption of grain legumes such as cowpea, groundnut and soybean contribute substantially to sustain crop production through their ability to fix atmospheric nitrogen, some of which is left behind in the soil after harvesting for subsequent crops. However the use of other associated technologies such as seeds, inoculants and labour saving technologies has greater potentials to accomplish increase of agricultural output, productivity and farmers' income (Assa, Mehire, Ngoma, Magombo and Gondwe, 2014).

Distance to production inputs also plays a significant role in the use of inputs among smallholder farmers. Assa, (2014) reported that distance plays a negative effect on the use of purchased inputs. Farmers are also constrained by the lack of information on, for example, prices, time to apply inputs, yield responses, appropriate inputs, fragmented landholdings etc. Even assuming that the information exists, it may not be within easy reach of farmers because extension services within the country have been severely affected by public sector budgetary constraints leaving many workers with their salaries paid but without funds to visit farmers (Assa, 2014). The decision on the use of purchased inputs requires information on prices and willingness to purchase inputs. Willingness to purchase inputs is also affected by risk and uncertainty among farmers.

Cowpea (*Vigna unguiculata* (L.) Walp) is one of the most economically important indigenous African grain legumes which is adapted to the savanna. Cowpea grain legume has the potentials of multiple contributions by not only ensuring household food production but also as cash crop (grain and fodder), source of livestock feed, and soil ameliorant. The appreciating economic importance was due to its food value which made it a good supplement/complimentary, source of protein for animal source (meat, egg and fish). Cowpea contains 20 – 25% of protein and 64% carbohydrate (Modu, 2009). In addition, the crop also helps in soil improvement by biologically fixing atmospheric nitrogen in the soil. Cowpea—indigenous to sub-Saharan Africa (SSA), is grown on about 14 million ha worldwide, with over 84% of this area in SSA. Between 1985 and 2007, the rate of growth was 4.5% in land area planted to cowpea, 4.5% in grain yields/ha, and 5.9% in quantity of cowpea produced (Rose, 2012).

Soybean *(Glycine max L.)* may contribute to the N needs of maize in West Africa. This crop has become increasingly important in Nigeria and has spread to large parts of guinea savannah zones where it is well adapted. Soybean may contribute to soil N through biological N_2 –fixation, some of which can be available to a subsequent maize crop. It may also absorb soil nitrate than maize, leaving more for a subsequent crop. It is believed that soybean production will increase as more farmers become aware of the potential of the crop, not only for cash/food but also for soil fertility improvement and control (Agbaje, Ogunbodede and Makinde, 2002)

Groundnut *(Arachis hypogea L)* is a leguminous crop belonging to the fabaceae family and is one of the world’s major food legumes grown by both developed and developing countries. Groundnut seeds contain high quality edible oil (50%), easily digestible protein

(25%) and carbohydrate (20%). It is grown on 26.4 million ha worldwide with a total production of 36.1 million metric tons, and an average productivity of 1.4 metric tons/ha –1 (FAO, 2004). Groundnut pod yields from farmers' field are low, averaging about 800 kg ha-1, less than one-third the potential yield of 3000 kg ha-1. This large gap between actual and potential yields is due to several factors, including non-availability of seeds of improved varieties for a particular ecology, poor soil fertility, inappropriate crop management practices, pests and diseases (Ahmed, Rafay, Singh and Verma, 2010).

1.2 Problem Statement

UNDP (1999) revealed that the development of agriculture in Nigeria is not meeting the demand of its teeming-population, despite the country's endowment with abundant and diversified range of natural, human and capital resources and oil revenue. Nigeria has remained one of the poorest countries in Africa. The transformation of agriculture from low productive traditional inputs to high productivity modern inputs is a major problem facing agricultural development in Sub-Saharan African countries including Nigeria (Ibrahim, 2006). Nigerian Government therefore, in trying to meet up with the teeming demand and ensure food security in the country has developed several policies and programmes (example; Green Revolution, Operation Feed the Nation, River Basin Development Authority And Recently Agricultural Transformation Agenda) to ensure increase food productivity to meet the demand of it increasing population. However, these programmes have not been able to adequately solve the food problems. Since the desired objectives have not been achieved and productivity of food crops has remained low. This low productivity may likely be attributed to soil fertility problems and other traditional practices among farmers. Soil fertility can be improved through the use of inorganic fertilizers which is highly expensive and in most cases in accessible to the farmers. The cost of inorganic fertilizer is very exorbitant that the resource poor farmers cannot afford even a single bag to apply to their crops for lack of financial resources. The low output realized by smallholder farmers is an indication that resources needed in the production of crops are not at optimal levels, (Nweze, 2002; Panwal, 2006; Adinya, 2008).

One of the critical problems hindering improvement in productivities of legumes is the traditional practices of cropping systems used by majority of the farmers as well as poor linkage to inputs and output markets. Although improved technologies such as strip cropping, seeds and inorganic fertilizers have been promoted among farmers, there is still the need to conduct comprehensive study to obtain information that could facilitate adoption of N2Africa grain legumes (i.e cowpea, soybean and groundnut) technologies for better agricultural productivity in Nigeria. In line with this, this research attempts to find answers to the following questions:

1. What are the socioeconomic characteristics of the legume farmers in the study area?
2. What are the factors that influence smallholder farmers' demand for purchase inputs in the study area?
3. Does socioeconomic characteristics influence adoption of N2Africa grain legumes technologies of among smallholder farmers?
4. How profitable are legumes production and associated technologies in the study area?
5. What are the input-output relationships of legumes production in the study area?

6. What are the constraints affecting input demand and adoption of grain legumes and associated technologies of N2Africa?

1.3 Objectives of the Study

The broad objective of the study is to analyze inputs demand and adoption of grain legumes and associated technologies of N2Africa in Kano State. However, the specific objectives of the study are to:

1. Describe socioeconomic characteristics of the grain legume farmers
2. determine factors influencing smallholder farmers demand for purchased inputs
3. determine the socioeconomic characteristics that influence adoption of N2Africa grain legumes technology among farmers in the study area,
4. estimate the profitability of N2Africa grain legumes production technologies in the study area,
5. evaluate the input-output relationships of N2Africa grain legumes production technologies in the study area; and,
6. Identify and describe the constraints militating against input demand and adoption of N2Africa grain legumes technology in the study area.

1.4 Justification of the Study

Adoption of legumes contribute substantially to sustain crop production through their ability to fix atmospheric nitrogen, some of which is left behind in the soil after harvesting for subsequent crops to utilize. Increased legumes production from intensified cropping system can play a key role in income generation in West Africa because of their multiple uses and fodder in human and animal diet. Legume is an important staple food and cheap protein source to rural and urban dwellers with the demand for the commodity increasing in the nation. Despite this importance, grain legumes can be grown together with cereals using certain technologies for the purpose of improving soil fertility improvement and better productivity. Legumes therefore have a tremendous potential to contribute to the alleviation of malnutrition specifically amongst the poor.

Hybrid seed, agrochemicals and chemical fertilizer utilization of the smallholder farmers ought to improve over time and space. Just as there is strong correlation between crop yield and the volume of purchase input utilization, so there ought to exist a relationship between the purchased input consumption of the farmer and selected socio-economic factors (Nwagbo and Achoja, 2001) which are at play in the micro environment in which the farmer operates. But it is difficult to generalize about the economic variables that are responsible for the growth in purchased inputs demand. For instance, variables which may correlate with purchase input consumption may relate to price of farm produce, market access conditions, fertilizer price per bag, farm size, farm income to mention but a few and each could have its own set of assumption (Assa, 2014). This study will try to investigate the potentials of grain legumes and associated technologies especially issues of adoption and profitability. This research is also important particularly to farmers and other investors in realizing the relevance of cropping system in soil fertility improvement for better productivity. The research will also provide information that are useful to policy makers in the development of policies that are important to improve agricultural productivity in Nigeria. This research work will be of great importance to other researchers in future and it will serve as the basis for further research that could contribute to improvement of livelihoods of the teaming population of smallholder producers in the study area.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 LEGUMES PRODUCTION IN NIGERIA

This component presents review of legume production in Nigeria, potentials of boosting legumes production as well as constraints affecting legumes production in Nigeria.

2.1.1 Review of Grain Legumes Production in Nigeria

Grain legumes include some of the major food and industrial crops of the Nigeria. The major legumes grown in Nigeria include groundnut, soybean and cowpea. These crops occupy a large proportion of cultivated area and are grown under a wide range of agro-ecological conditions, although the distribution varies with the specific ecology within each zone. They are grown extensively in the North-East, North-West and North-Central zones, and in the sub-humid and semi-arid regions (Shaib, Aliyu and Bakshi, 1997). A review of the data reveals that starting from the late 1980s, appreciable increases in output were recorded in some crops, however, there were abrupt and large shifts in production which could be explained by extensive research carried out on varietal improvement by IAR, IITA and NCRI, and the general awareness created among the farmers on the need for increased food production following campaign programs, such as the Green Revolution and others.

Grain legumes constitute a substantial percentage of the total crop requirement of Nigeria to attain the dietary needs of its people. For instance, between 1996 and 2003 aggregate average demand for groundnut (2.85 MMT) exceeded aggregate average annual production (2.31 MMT). Furthermore, aggregate average demand for soybean (0.76 MMT was more than double the aggregate average production (0.34 MMT).

(Richathofen, Pahl and Nemecek, 2006). Similarly, average annual production of cowpea between 1996 and 2001 (1.84 MMT) was about 38% below the aggregate average demand (2.94 MMT). However, the implementation of presidential initiative on vegetable oil development program (VODEP) led to reasonable growth in output of groundnut and soybean. For instance, between 2004 and 2007, aggregate average output of groundnut (3.69 MMT) was more than average demand (3.46 MMT), and aggregate average output of soybean (1.46 MMT) was higher than the aggregate demand (0.89 MMT). This does not necessarily mean the attainment of self-sufficiency in these grain legumes but rather suggests that the excess demand had been wholly absorbed by accelerated production of these legumes by VODEP which had the mandate to increase the production of vegetable oils during the period (2003-2007) and as such, promoted the production of these oilseed legumes for the achievement of its objectives. This is an indication that specific programmes directed at increased production of legumes could indeed accelerate their production. Similarly, the introduction of improved varieties by research institutes had increased the output of cowpea from a value of 3.52 MMT in 2001 to as high as 4.98 MMT in 2007 which was more than the aggregate demand during the period indicating the need for a specialized research institute for grain legumes for further productivity increases (Richathofen, Pahl and Nemecek, 2006).

2.1.2 Prospects of Boosting Grain Legumes Production in Nigeria

The economic importance of grain legumes rests on their advantage as food and feed crops because the grains have high calorie value, rich in proteins of high quality to feed humans and animals and are high income generating. Proteins are food nutrients essential for growth, repairs and development; however, they are in short supply in many parts of the world. The human consumption of protein, and still more strikingly the ratio of animal versus total protein in the diet, varies considerably from one part of the world to the other. In Nigeria, local production of protein rich crops has not been adequately addressed while most diets consist mostly of carbohydrates. The country had relied mainly on protein from animal sources. However, the limitations of these sources include: unfavorable climatic condition for livestock production, inadequate supply and high cost of production inputs, and high cost of animal products which cannot be afforded by majority of Nigerians especially the rural poor (Katsa and Maku, 2004). As a result of these limitations and the concern to bridge the gap between protein requirement and production, the production of grain legumes as inexpensive sources of protein should be boosted in the country. According to (IFAD, 2009), protein availability can be boosted by increasing the supply of grain legumes rather than organizing mostly feeding programmes based on protein rich foods of animal origin. Similarly, Eskola (2005) stated that, grain legumes contain as much protein as animal sources and are therefore the most practical means of eradicating protein malnutrition, since they are a good inexpensive sources of various 1nutrients, notably protein, iron and B vitamins.

Grain legumes, apart from their uses as food for man and feed for animals, are economic crops used for exports, production of oil, wines and soap in many parts of the world, particularly Middle East. Nigeria has untapped potential for increasing GDP in the utilization of grain legumes. In the event of the ban on importation of vegetable oil into the country, oilseed legumes have provided excellent sources of raw materials to boost the local production of vegetable oil. Oil is a valuable product with universal demand,

and the possible income from oil extraction is, therefore, often enough to justify the relatively high cost of setting up and running a small oil milling business (FAO, 2010).

Legumes promote diversity and efficiency in agricultural rotations thereby providing long term benefits that are difficult to convert into monetary value. Grain legumes are particularly relevant for sustainable cropping systems as shown by the results of economic and environmental studies undertaken within the scope of the Concerted Action Glo-Pro. Unlike other cultivated plants, as a result of the symbiosis with nitrogen-fixing bacteria, legume crops do not need nitrogen fertilization for optimal growth in general. Legume crops play very important role in crop rotations, especially in poorer soils. They are a key component of sustainable agriculture as they contribute to breaking disease cycles in cereals-rich rotations and improve soil structure. They are also used for green forage in pure stand or legume/cereal mixtures as well as for green manure to improve the fertility and structure of poor soils (Szyrmer and Boros, 2006). In a study on the environmental consequences of diversifying rotations with grain legumes, Richathofen, Pahl, and Nemecek (2006) found out that, in intensive cropping systems, with a high proportion of cereals and high N-fertilizer input, the incorporation of grain legumes has especially beneficial effects on the environment. With respect to pollutant management, introducing grain legumes in the crop rotation contributes to lower eco and human toxicity. Less herbicides and fungicides are used because grass weed infestation and certain diseases in cereal-rich rotations are reduced by the break-up crop effect of grain legumes. Abayomi, (2001) affirmed that introducing grain legumes in crop rotations with a high proportion of cereals leads to a slightly higher gross margin by the break-crop effect of grain legumes. Versteeg, (1998) had earlier reported that, organic inputs from legumes could increase crop yield through improved nutrient supply and/or improved soil water-holding capacity. Moreover, legumes offer benefits such as providing cover to reduce soil erosion, maintenance and improvement of soil physical properties, increasing soil organic matter, cation exchange, microbial activity and reduction of soil temperature. (Amoo, 2005) also pointed out that, apart from their beneficial effect of N-fixation in the soil, grain legumes suppress weeds, have less potential for environmental degradation, and improve soil physical conditions and water retention.

2.1.3 Constraints and Challenges Affecting Legumes Production in Nigeria

The bulk of the domestic supplies of legumes come from the small-scale farmers. These producers operate under limitations imposed mostly by poverty and inadequate knowledge. The grain legume crop sub-sector has also been constrained by escalating costs of production and reduced purchasing power of farmers; poor state of rural infrastructure which makes the rural environment unattractive to the younger generation and rural investment unviable; inadequate availability of inputs, especially improved seeds, fertilizers, agro-chemicals and farm machinery compared to farmers' needs; credit; weak agricultural extension delivery services resulting in ineffective dissemination of modern farming technologies and poor feedback mechanism for research to respond to farmers needs; poor funding of agricultural development activities; inadequate appropriate technology to reduce the drudgery in agricultural production and processing activities; ineffective control of pest and diseases; and low capacity of the organized farmer groups in service delivery (IFAD, 2009).

2.2 CONCEPTUAL FRAME WORK

This component presents conceptual frame work on inputs demand and adoption of agricultural innovations.

2.2.1 Conceptual Frame Work on Inputs and Demand

The term agricultural inputs are defined as those raw materials that are subjected into agricultural production process for the provision of certain output. Agricultural inputs can either be fixed or variable resources. The variable are those operational resources commonly required among smallholder farmers which includes fertilizers, seeds and agro chemicals while the fixed inputs are those durable resources such as the land and other farm tools. Variable resources constitute the major expenditure mostly among smallholder farmers as the incomes required for the purchase of such inputs are not adequate. It is widely accepted that increased demand of purchased inputs (seeds, chemicals and fertilizers) has a critical place, alongside organic soil fertility enhancement practices, in the technical change needed for sustained smallholder agricultural production. However, purchased input use is very low amongst the farmers especially from Sub-Saharan Africa and has remained largely static over the last 20 years or so, with particularly low usage in smallholder food-crop production where constraints on expanded purchased inputs (seed and fertilizer) use exists on both the supply and demand sides. Five sets of issues are explored as related to inputs demand in Agriculture:

- Affordability
- Availability
- Information
- Uncertainty

- Commercial context

There is no prioritization implicit in the order of the topics, they are all important and linked by many interrelated issues. Whilst some of these topics may seem obvious, most have several dimensions. In the following section, where strategies to increase the use of purchased inputs are explored, the importance of these different dimensions becomes clearer. Thus, for example, affordability can be improved by a change in the timing of sales.

Affordability

Many African smallholders cannot afford to buy agricultural inputs. Although this is a straightforward enough concept, it does encompass different dimensions. At its simplest, farmers cannot afford inputs because they are too expensive. Many agricultural inputs have been subject to dramatic price increases as a result of the removal of subsidies, price controls and currency depreciation. Gibbon (1992) reports that under structural adjustment in Ghana, fertilizer and pesticide price rises exceeded inflation by a factor of five or six. In some cases, the price structure and yield response is such that the use of certain inputs may no longer be justified on crops produced for the domestic market. Whether or not this is the case, most African smallholders have limited purchasing power and agricultural inputs represent a major outlay. Whilst there may be some profiteering by traders, there are many other factors which contribute to the inherently high costs of delivering inputs to farming areas, under the market and infrastructure conditions prevailing at the present time. These factors include:

- Low volume imports – so less discount for bulk purchases and higher per unit transport costs (the latter is particularly true of land-locked countries);

- Dispersed local markets making low volume purchases in a tightly concentrated seasonal window – which all contribute to high costs per unit of input;
- Poor roads and telecommunications, and transport bottlenecks (including the operation of transport cartels) increase transaction costs;
- Payment of bribes in order to obtain timely import clearance on seasonal inputs, similarly bribes may be needed at other points in the transport chain.

Closely related to price are the cash costs involved in input purchase other than the price of the input itself (there are other non-cash costs too, including the time needed to find out about inputs and to source them). The purchase of inputs may require the farmer to travel to a local (or distant) town, necessitating expenditure on transport and accommodation, it may also require phone calls (where these are possible), or even signing up for a larger package which includes unwanted inputs. Some farmers in Uganda apparently sign up for seed and fertilizer packages available through development projects, simply to obtain the seed, which is in short supply.

Some inputs would be more affordable if they were available in smaller pack sizes (notwithstanding the additional packaging costs). African farmers tend to plant small areas; they plant many crops and they intercrop. When they try out new seed they often only want small quantities initially and may still demand modest quantities of seed which is known to them. Obvious though this may be, inputs such as seed are often not available in sufficiently small pack sizes. Even purpose-built seed handling systems may not have appropriate pack size capacity. (For example, the Uganda Seed Project, a parastatal concerned with smallholder seed provision, has the capacity for 25 kg and 10 kg seed packs. In an attempt to respond to farmer needs, they fill 5 kg and 2 kg packs manually, but recognize that pack sizes of 1 kg and 500 g would be better still.) Whilst retail outlets, projects or farmers may split packs, this always calls into question seed quality guarantees.

The decision to purchase inputs for a particular crop may be influenced by access to cash within the household and traditional domains of decision making. Whilst men are often involved in the production and marketing decisions concerning traditional cash crops, women tend to play a greater role in the production and marketing of food crops. They may find that their husbands do not attach a priority on input needs for these crops, whilst their own resources may be too stretched to extend to input purchase.

Availability

Even when households can afford inputs, they may be unavailable. Again, there are several aspects to this. Despite large numbers of farmers, many African countries represent very small markets for agricultural inputs, largely because of low purchasing power. Thus many inputs may not be available in the country simply because the volumes that can be sold are small. Consideration of aggregate availability may conceal some important distinctions. Fertilizer may not be available in the appropriate formulations, for instance, or important complementary inputs may not be available, thereby reducing the effectiveness of the overall package.

Farming is a highly seasonal activity and inputs are needed at very specific times. Some peak needs can be anticipated (seed at planting time for instance, even if planting dates shift depending on rainfall), whilst others arise at short notice (the sudden emergence of a pest requiring rapid action to save the crop). Where inputs need to be imported at short notice, it is unlikely that the market can respond in time, and even where it is a question of distributing inputs from the capital to rural areas, information and transport constraints may prevent a sufficiently timely response. For the farmer, the non-availability of inputs often manifests itself in the first instance in the absence of local agricultural input retailers. Farmers must generally travel some distance to locate inputs (sometimes to the capital) with no guarantee of success or affordability. Moreover, where input needs arise at short notice during the planting season, there is an especially high premium on the farmer’s time, making the uncertainty and absence of local outlets all the more problematic.

Access to Information

Information constraints arise at different levels. The information constraint is first of all apparent in the straightforward lack of reliable information on yield response to, for example, fertilizer, under the conditions and soils prevailing in farmers’ fields. Application of inputs at an inappropriate time, or inputs of poor quality, may contribute to a perception of unreliable information on yield response. Even assuming that the information exists, it may not be within easy reach of farmers. Extension services in many countries have been severely affected by public sector budgetary constraints leaving many workers with their salaries paid but without funds to visit farmers. In many cases they are doing the best they can in difficult circumstances, but certain problems are widespread:

- Bias towards less poor farmers, men and accessible farmers;
- Lack of printed extension material available in local languages;
- Messages not suited to conditions which prevail in farmers’ fields;
- Inflexibility in adapting messages to farmer needs.

As a consequence farmers rely heavily on information available from other sources:

- Friends and family;
- Farmers with privileged access to information, for example, those involved in trials, demonstration plots, seed multiplication or contract farming;
- NGOs and development projects;
- Farmers' groups and associations;
- Radio and newspaper;
- Traders and purchasers of farmer crops;
- Farm input retail outlets (where they exist);
- Information provided with the product.

The first four are likely to have only piecemeal information expanding the farmer's knowledge, but with no certainty that s/he has sufficient information on which to make a well-informed choice between technologies or inputs. Mass media may, in some countries, provide targeted farmer information services but in many countries provision for farming communities is weak. Traders can be a good source of information on preferred varieties and may actually see enough farmers to gain an understanding of problem remedies that work. Companies buying particular products, or running contract farmer schemes, are more likely to have knowledgeable field agents.

In an ideal world, retail outlets would offer comprehensive impartial advice on the farm inputs available. Often, however, there is an incentive for the trader to promote a particular product, and in many areas there is no alternative supplier to which the farmer can turn for a second opinion. (Recent work by NRI in India suggests that where retailers are farmers themselves, and located within the farming community, they are more likely to offer impartial advice.) Where products are retailed in their original packaging, information provided with the product is likely to comply with international standards (giving the active ingredients, intended use, recommended rates and methods of application, and shelf-life). However, this information may be in an inaccessible form (for example, written in small dense print, in a non-native language, using technical terms). Such inaccessibility may extend to the retailer as well as the farmer. An informed decision on the use of purchased inputs also requires information on prices, and in thin markets (i.e. those with low and uneven volumes of transactions over time), prices can be particularly uncertain and variable

Risk and Uncertainty

Farmer willingness to purchase inputs is also affected by risk and uncertainty. Low and uncertain rainfall is closely linked to low use of purchased inputs, since it creates additional yield risk. Most African agriculture is rain-fed, only 8% of cereal production is irrigated, compared with 20–40% in other developing regions. Where output prices are volatile, farmers may be unwilling to apply inputs for fear that they may not cover costs. Chemicals, in particular, are often very specific and expensive and farmers will be reluctant to apply them unless confident of their suitability. Unviable seeds are another problem. Whilst suppliers may willingly replace or refund when seeds are found to be unviable, planting has to be repeated and the ideal sowing date has passed.

Commercial Context

There are a number of ways in which the commercial context affects the use of purchased inputs. These issues overlap with some of the other topics already discussed, but as a group they offer an additional explanation for overall levels of input use. Farmers' expectations of being able to market their crop at a remunerative price are an important determinant of willingness to use purchased inputs. Although market prices may vary, some will be subject to larger fluctuations than others. With sufficient experience, farmers may, nonetheless, develop technology strategies which are robust in the face of expected price variation, or where resources permit, may be able to take a calculated risk on the likelihood of covering costs. Where debt amnesties and subsidized credit programmes have been common, it may be more difficult to establish viable credit schemes than in situations where those taking out loans expect to repay them. The absence of retail outlets is not limited to farm inputs. It affects all sectors and reflects the limited purchasing power of farming communities. When taken together, these factors which reduce access to inputs, combine to create an additional disincentive: high and unpredictable transaction costs. Trading in small quantities, to dispersed markets, with irregular, seasonal demand, contributes to high transaction costs (low volume transactions incur the same fixed ‘negotiation’ costs as those for higher volumes, and also incur higher unit transport costs than could be negotiated for regular or larger shipments, exacerbated by lack of competitive pressure). High transaction costs incurred by the trader translate into higher retail prices, and in addition to these, transaction costs incurred by the farmer contribute to uncertainty and conflict with alternative uses of his/her time and resources. Farmer willingness to use purchased inputs depends in part on the overall commercial environment, including the extent to which farming decisions are influenced by business (profitability) criteria.

2.2.2 The Conceptual Framework on Adoption of Agricultural Innovations

Various authors define the term "technology" in a variety of ways. Rogers (1995) uses the words 'technology' and 'innovation' synonymously and defines technology as the design for instrumental action that reduces the uncertainty in the cause-effect relationship involved in achieving a desired outcome.

A more meaningful definition may be that a technology is a set of 'new ideas' (Jackline, 2002). New ideas are associated with some degree of uncertainty and hence a lack of predictability on their outcome. For a technology to impact on the economic system, blending into the normal routine of the intended economic system without upsetting the system's state of affairs is required (Jackline, 2002). This entails overcoming the uncertainty associated with the new technologies. It therefore comes as no surprise that several studies set out to establish what these factors are and how they can be eliminated (if constraints) or promoted (if enhancers) to achieve technology adoption (Jackline, 2002). In most cases, agricultural technologies are introduced in packages that include several components, for example, high-yielding varieties, fertilizers, and corresponding land preparation practices. While the components of a package may complement to each other, some of them can be adopted independently (Feder, 1985).

Also Feder, (1985) defined adoption as the degree of use of a new technology in long run equilibrium when a farmer has all of the information about the new technology and it's potential. Feder (1985) classified adoption as individual (farm level) adoption and aggregate adoption. Therefore, adoption at the farm level describes the realization of a farmer's decision to implement a new technology. On the other hand, aggregate adoption is the process by which a new technology spreads or diffuses through a region. Thus, a distinction exists between adoption at the individual farm level and within a targeted region. If an innovation is modified periodically, however, the equilibrium level of adoption will not be achieved.

The literature shows that influences on adoption can be conceptualised as related to either, 1) learning about relative advantage, or 2) the actual relative advantage. Similarly each influence can also be characterised as being related to the population or to the innovation. The conceptual framework at its simplest has four quadrants. The left-hand quadrants—*Population-specific influences on the ability to learn about the innovation* and the *Learnability characteristics of the innovation*—only influence the time taken to reach peak adoption; they do not influence the peak adoption level. The right-hand quadrants *Relative advantage for the population* and the *Relative advantage of the innovation* influence both the time taken to reach peak adoption and the peak adoption level. They influence the time taken to reach peak adoption in two ways, because *Relative Advantage* also affects the *Learning of Relative Advantage* node. The main factors affecting technology adoption among smallholders in Sub-Saharan Africa are assets, vulnerability, and institutions (Meinzen-Dick, 2004).

2.2.3 Conceptual Frame Work on Regression and Gross Margin Analysis

Regression analysis is an inferential statistics tool that shows relationship between dependent and independent variable. Regression models are classified into simple and multiple regression analysis. The simple regression analysis is a situation in which there is inclusion of only one independent variable in the model while the multiple regression is a situation in which there is two or more independent variables.

Classical assumptions for regression analysis include:

1. The sample is representative of the population for the inference prediction.
2. The error is a random variable with a mean of zero conditional on the explanatory variables.
3. The independent variables are measured with no error. (Note: If this is not so, modeling may be done instead using errors-in-variables model techniques).
4. The independent variables (predictors) are linearly independent, i.e. it is not possible to express any predictor as a linear combination of the others.
5. The errors are uncorrelated, that is, the variance–covariance matrix of the errors is diagonal and each non-zero element is the variance of the error.
6. The variance of the error is constant across observations (homoscedasticity). If not, weighted least squares or other methods might instead be used.

Logistic regression is a type of regression model where the dependent variable is converted into dichotomous/binary variables coded 0 and 1 (Brian and Sabine 2004). The model uses maximum likelihood estimation (MLE) procedure. The advantage of this is that, the probabilities are bound between 1 and 0. Logit regression conceptually gives maximum estimates, overcome the shortcomings associated with linear model of regression and provide estimates that are consistent and efficient (Pindynk, 1998). However, unlike the ordinary least square (OLS), although it can be used to estimate binary or dichotomous natured model, certain assumptions of classical regression model will be violated such as non-normality of the disturbance, heteroscedastic variance of the disturbance and a questionable value of R^2 as measures of goodness of fit (Gujarati, 2004).

The gross margin for a farm enterprise is one measure of profitability that is a useful tool for cash flow planning and determining the relative profitability of farm enterprises. Gross margin profit is the difference between the annual gross income for that enterprise and the variable costs directly associated with the enterprise (David, Jim and Daniel, 2013). Gross Margin can also be defined as the gross income from an enterprise less the variable costs incurred in achieving it. Variable costs are those costs directly attribuTable to an enterprise and which vary in proportion to the size of an enterprise. For example: If the area of wheat or sorghum sown doubles, then the variable costs associated with growing it, such as seed, chemicals and fertilizers, will roughly double. If the number of breeding cows' doubles, then the variable costs associated with carrying the additional stock, such as drench and vaccination costs, will also roughly double. In constructing gross margins, fixed (overhead) costs are ignored, as it is considered that they will be incurred regardless of the level of the enterprise undertaken. The gross margin of different enterprises should not be compared if they have different overhead costs.

2.3 REVIEW OF EMPIRICAL STUDIES

This component present empirical study on purchased inputs demand and adoption and profitability of grain legumes among smallholder farmers.

2.3.1 Empirical Study on Inputs Demand among Smallholder Farmers

Assa, Mehire, Ngoma, Magombo and Gondwe (2014) conducted a study on Determinants of Smallholder Farmers' Demand for Purchased Inputs in Lilongwe District, Malawi. The aim of this study was to empirically determine the factors that affect smallholder farmers' demand for purchased fertilizer and seed using cross section data. Model solutions, which were created by using Translog Cost function were carried out by Seemingly Unrelated

Regression (SUR). The study revealed that education, field size (plot of land cultivated) and household size have significant negative relationship with the share of fertilizer purchased and positively related with share of seed. Whereas price of output, seed, fertilizer and income of the household are found to be significant and positively related to share of fertilizer and negatively related with share of purchased seed.

Ezeh, Onwuka, and Nwachukwu (2008) investigated the correlates of inorganic fertilizer consumption among smallholder farmers in Abia State, Nigeria A multi – stage random sampling technique was employed in selected local government areas, communities and farmers from the three agricultural zones (Aba, Ohafia and Umuahia) of the state making sample size of 150 farmers for the study. The results of the linear functional model indicate that four (farmer incomes, farm experiences, transportation costs and price of 50kg fertilizer bag) out of the eight variables were key determinants of the smallholder farmers' fertilizer consumption at 5% risk level. However the combined effects of all the variables explained 57.6 percent of the variations in the total fertilizer consumption rate of the smallholder farmers in Abia state Nigeria. Higher level of subsidy on fertilizer is recommended as a deliberate policy to increase the fertilizer consumption propensity of the smallholder farmers.

Amsalu, Kindie, and Belay. (2013) conducted research on determinants of household demand for and supply of farm labour in rural ethiopia. Typical farm households in rural areas of developing countries allocate their labour resource among own-farm work and off-farm (market) activities in response to different factors. This study examines determinants of household demand for and supply of farm labour in rural western Ethiopia using household sample survey data collected during 2010/11 agricultural season. The instrumental variable estimation technique used to analyze the data indicates the importance of shadow wage, shadow income, and demographic factors at influencing farm labour supply. Similarly, the demand for farm labour is significantly affected by farm attributes, off-farm income and family composition. The findings with regards to farm labour supply imply that measures taken to influence returns to labour on farm may produce different results for labour market project and non-project households. Moreover, increasing the off-farm employment opportunities can help release the liquidity constraint and thus promote increased use of hired farm labour.

2.3.2 Empirical Studies on Adoption of Agricultural Innovations

Many studies were conducted on adoption and factors that influence adoption of agricultural technologies. Some of the adoption studies conducted in Nigeria and Africa in general includes the following:

Idrisa, (2012) examined the determinants of adoption of improved soybean seeds among farmers in southern Borno State, Nigeria. Inferential statistical techniques namely the Logit model and the Tobit model were used to estimate the likelihood of technology adoption among farmers and the extent of adoption of improved soybean seeds by the farmers, respectively. Yield of soybean and distance to source of improved seeds were statistically significant factors that influenced the likelihood of adoption of improved soybean seeds among the farmers. Farm size and distance of farmers to source of improved soybean seeds were statistically significant factors that influenced the extent of adoption of improved soybean seeds among the farmers. Based on the findings of this study, it was recommended that improved technologies in the form of high yielding seeds varieties should be made available to farmers. Farm service centers should be established within reasonable distance from farming communities. This brings technologies closer to farmers, thereby reducing the risks that farmers have to encounter to get farm inputs.

Bello, Dauda and Okwu. (2011) conducted a study focused on the factors influencing the adoption of farming technologies among farmers in Jenkwe Development Area (JDA) of Nasarawa State of Nigeria. The research farmers consisted of 96 farmers from five districts of the development area selected through simple random sampling technique. The results were analyzed using descriptive statistical tools involving frequency, percentage and means in respect to farmers' characteristics. Regression analysis using the Statistical package of Social Sciences (SPSS) was used to determine the relationship among the variables. The results showed significant negative relationship between adoption and number of farm plots and farm size positively significant correlation with years of farming experience and farm income.

Solomon, (2011) examined the driving forces behind farmers’ decisions to adopt agricultural technologies and the causal impact of adoption on farmers’ integration into output in Ethiopia. They used a Double-Hurdle model to analyze the determinants of the intensity of technology adoption conditional on overcoming seed access constraints. Results show that knowledge of existing varieties, perception about the attributes of improved varieties, household wealth (livestock and land) and availability of active labor force are major determinants for adoption of improved technologies. Their results suggest that the adoption of improved agricultural technologies has a significant positive impact on farmers’ integration into output market and the findings are consistent across the three models suggesting the robustness of the results. This confirms the potential direct role of technology adoption on market participation among rural households, as higher productivity from improved technology translates into higher output market integration.

Haji (2003) examined the adoption of crossbred dairy cows in Arsi zone used Logistic regression model to identify factors affecting farm households' adoption decision of crossbred dairy cows. Formal education, total local livestock holding, the distance between farmers' residence and market, family size, total cultivated area, access to credit, access to artificial insemination, access to bull service, farmer's leadership position in local farmers' organization and extension contact were found to be significant variables in the adoption decision of crossbred dairy cows.

Orebiyi, Benchendo, and Onyeka, (2007) investigated the adoption level as well as the factors influencing the ADP contact farmer's adoption of improved cassava production technologies in Imo State of Nigeria. The data were analysed using the linkert scale method to determine the adoption level of the contact farmers while multiple regression analysis was used to isolate factors that are very critical to this study. The results showed that the grand mean adoption level of the farmers was 0.61 with the planting of improved cassava varieties having the highest adoption score of 0.72 while tillage practices had the least score of 0.49. The value of the coefficient of multiple determination (R^2) was 0.879 implying that the farmers' age, educational level of the contact farmers, level of extension contact, availability of production credit as well as other farm inputs were statistically significant factors influencing the adoption of improved IITA cassava production technologies in the state.

2.3.3 Empirical Studies on Profitability Analysis

Ya'aishe, Alice, Putai and Petu-Ibikunle (2009) examine economic analysis of cowpea production among women farmer in Askira/Uba Local Government Area, Borno State Nigeria. Analytical tools such as descriptive statistics and regression analysis were used for the analysis of the data. The analysis revealed that the coefficient of farm size was positively significant at (10%) hired labour was negatively significant at (10%) and the coefficient for mechanized labour was positively significant at (1%) leave respectively. Costs farm income and gross margin analysis per hectare for cowpea, production were ₦28,255.42, ₦75,032.26, ₦46,780.08 respectively.

Musa, Vosanka, Inuwa, and Mohammed (2010) conducted study the economics of cowpea production in Donga Local Government Area of Taraba State. The specific objectives were to determine the profitability of cowpea production and identify the major constraints of cowpea production. The returns was estimated at ₦153, 250.00 for gross income, with gross margin, net income and per naira invested estimated at ₦66, 005.00, N37, 380.00 and ₦0.7565.00 respectively.

TaruL, Kyagya and Mshelia (2010) examines the profitability of groundnut production in Michika Local Government Area of Adamawa State. Gross Margin analysis was strictly used. From the costs and return analysis, it is found that the total cost of production by farm size per hectare in the area is ₦133, 812.68; the gross margin per hectare is ₦221348.68 while the average net return per hectare is ₦40, 097.63. The findings also shows that, farmers in the area earned an average net revenue ranging between ₦17, 217.00 and ₦445, 011.35 depending on farm size which indicated that groundnut production is a profitable venture in the study area. Farmers should maintain output per hectare at a high level with the family labour at their disposal through good management and efficient use of modern inputs.

Olorunsanya, Babatunde, Orebiyi And Omotosho (2009) examines the efficiency of resources used in soybean production in Kwara State using 120 representative farmers. The costs and returns analysis revealed soybean production as a profitable enterprise with net farm income of ₦8,217.5 and rate of return of 62%. The regression results show labour in mandays, farm size in hectares and quantity of seeds in kilogramme determined the production of soybean in the study area and should be the focus for policy targeting. Further analysis showed that land was underutilized while seeds and labour were over utilized. It was therefore recommended that more of land area should be utilized while less of quantities of labour and seeds should be used for optimal profit to be attained in the study area.

Abu, G. A. (2012) analyzed the scarce resource allocation in the special crop programme between farmers who participated in this programme and who did not. Data collected were analyzed using descriptive statistics, gross margin analysis and regression analysis. A significant difference in output was found between project and non-project farmers. The per hectare average cost of production for soybean project farmers was ₦33,624. The gross margins per hectare ₦26,734 soybean were found to be profitable. The results of the multiple regression analysis showed that 83 and 67% of the variations in soybean yield were explained by the combined effect of herbicide, fertilizer, seed and labor for project and non-project farmers respectively. Soybean farmers (both projects and non projects) were producing in stage two, the rational stage of production.

CHAPTER THREE

3.0 METHODOLOGY

3.1 The Study Area

The study area covers Kano State located in the north-western part of the Nigeria. Kano State has coverage of 44 Local Government and the state share boarder with Jigawa, Kaduna, Bauchi, and Katsina state respectively. Kano State was created in 1967 and lies between latitude 10^0 33’ and 12^0 37’ North of the equator and longitudes 7^0 43’ and 9^0 35’ East of Greenwich. The population of Kano in 2011 was 9,383,682 people (NPC, 2006) and the current estimated population at 3.5% stands at 12,000,000 (GEMS, 2013).

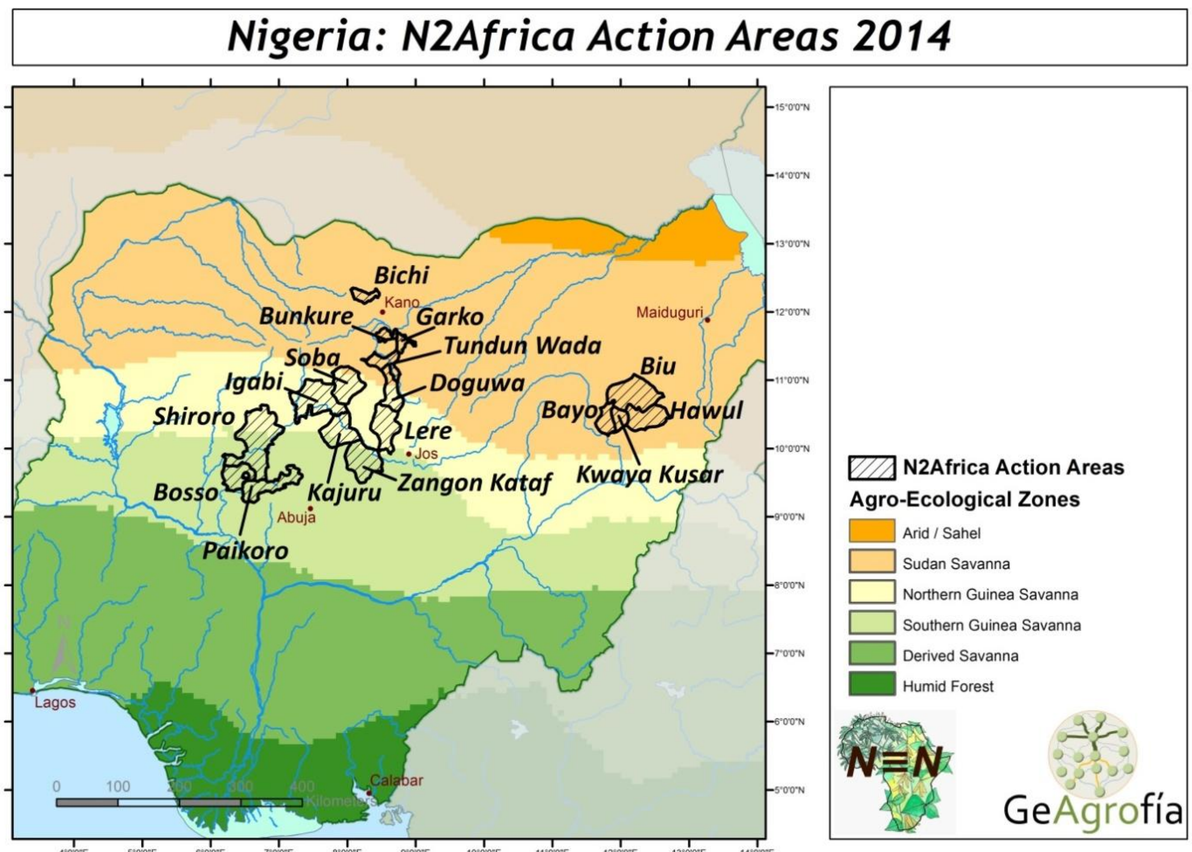
Kano State lies in the tropical wet and dry climate zone. The mean rainfall is about 1000mm in the southern part of the state, 800mm around metropolitan Kano and about 600mm in the north-east. The rainy season usually covers the months of April – October. This is followed by harmattan which usually begins in November and ends in February.

The primary activity of the populace is farming in rural areas and business in the urban centers. The secondary occupational engagements include: civil service, animal husbandry, marketing of agricultural products etc. Traditional farming system is the dominant practice among most of the farmers with emphasis on mixture of cereals and legumes. Most of the farmers in Kano state practice traditional farming system cultivating local varieties of cowpea, millet, maize, sorghum and groundnut in various intercropping systems with little or no purchased inputs (KNARDA, 2011). On the basis of livestock production, sheep, goats and cattle production are commonly available especially among rural dwellers in the study are.

Table 1: Summary of the Project Area

S/n	LGAs	Area (km^2)	Population	Communities selected by N2Africa
1	Bichi	612	277,099	Badume, yakasai, sabo, dangawo, faras, gara, mangwarau, munbira, jobe.
2	Bunkure	487	170,891	Gurjiya, jallorana, sabon ruwa, z/Buhari, zanya, maslaure, gabo, falingo, Bunkure.
3	Doguwa	1,204	231,742	Maigado, tagwaye, yantame, dandoki, dadin kowa, ragada karami.
4	Garko	450	162.500	Danmaliki, karfau, garwaji, gurjiya, lamire, kakiya, dakare, Tudun zaki.
5	T/wada	1,473	151,181	Jammaje, tashar gora, yarmaraya, marmara, tashar inji, damaga, dogon kawa, yaryasa.

Source: CADP (2010) & N2Africa (2014)



3.2 Method of Data Collection

The research employs the use of primary data. The primary data were obtained using a structured questionnaire with the assistance of trained enumerators carefully selected by the researcher who can interview and communicate effectively in the manner that can influence farmers to give sufficient information. The questionnaire provide information on socioeconomic characteristics, determinants of inputs demand, socio-economic factors influencing adoption of legumes, profitability analysis, input-output relationship of legumes production, constraints affecting inputs demand and adoption of legumes production technologies of N2Africa in Kano state.

3.3 Sampling Techniques

Multi-stage sampling techniques were used for this research. The study consider ten (10) local governments purposefully where N2Africa Phase 1 project was introduced. Specifically fifty percent (50%) of the local government areas were selected giving a total of five (5) Local Governments Areas from the project area. The local governments selected include Bunkure, Bichi, Garko, Doguwa and Tudun wada. Two participating communities were randomly considered from each local government giving a total of ten (10) communities from the intervention areas. Three (3) participating farmer group were also randomly considered from the communities and thus thirty (30) farmer groups were considered from the intervention areas. Finally, five (5) farmers were randomly considered from each of the participating group and this give a total of 150 farmers as sample size from the project areas.

Five local governments were also considered randomly from non-project areas with emphasis of avoiding locations that are proximate to project areas. The local governments selected include Gezawa, Madobi, Rimin Gado, Ungogo and Tofa. Two (2) communities were randomly used in each of the non-project local governments giving a total of ten (10) communities. Fifteen farmers were selected from each community and thus 150 farmers were considered from non-intervention areas. Doguwa and Tudun wada represent sample of soybean farmers in the project area while Rimin gado and Tofa represent sample of soybean farmers form non-project area.

Table 2: Summary of the Sampling

Project Area (5*2*3*5=150)				**Non-project Area (5*2*15=150)**		
L.G.As	No. of communities	No. of group	No. of farmers	L.G.As	No. of communities	No. of farmers
Bunkure	2	6	30	Gezawa	2	30
Bichi	2	6	30	Madobi	2	30
Garko	2	6	30	Rimin gado	2	30
Doguwa	2	6	30	Ungogo	2	30
T/ wada	2	6	30	Tofa	2	30
Total	**10**	**30**	**150**		**10**	**150**

Source: preliminary survey, 2015 **n=300**

2.4 Data Analysis

Descriptive statistics were used to achieve objective 1 and 6, Multiple regression were used to achieve objective 2 and 5, Logit regression for objective 3 and Gross margin analysis for objective 4.

2.4.1 Descriptive Statistics

Descriptive statistics such as frequency and percentage, mean, minimum and maximum, standard deviation and standard error were used, The descriptive approach is briefly explained below:

Arithmetic Mean: this is the set of scores divided by the total number of the observation. Mean is written mathematically as:

$$X = \frac{\sum Xi}{n} = \frac{X_1\ X_2\ X_3 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots X_N}{n} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where;

X = Arithmetic mean

$\sum$ = Summation

X_I = Individual observation

I = 1, 2, 3…………………n

Percentage: This was employed to determine the population of farmers to a particular response. Percentage is written mathematically as:

$$\text{Percentage } (\%) = \frac{X}{n} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(2)$$

Where;

% = percentage

X = Individual observation

N = Total observation

2.4.2 Inferential Statistics

Inputs Demand Models

The quantity demanded of purchased inputs for legumes production depends on the price of the inputs, price of other inputs (substitute, complementary), producers income, size of land devoted for legumes production and distance of the producer to the input market (source) ceteris paribus. The quantity of purchased inputs demanded for legumes production is expressed mathematically as follows:

$Q_d = f(P, Y, H, d)$……………………………………………………………........(3)

The explicit forms of the models for this study are specified below:

Multiple Regression (Inoculants Demand Model)

$Qd_i = \beta_0 + \beta_1 P + \beta_2 Y + \beta_3 H + \beta_4 D + U$………………………………………………....(4)

Where;

Qd_i = quantity of inoculants purchased in kg

P_i = price of inoculants in Naira/kg

Y_i = producers income in Naira/season

H_i = land size devoted for legumes production in hectare

D_i = distance to input market (source) in kilometer

$B_o – \beta_4$ = Coefficients to be estimated

U = Noise term

Multiple Regression (Seeds Demand Model)

$Qd_s = \beta_0 + \beta_1 P + \beta_2 Y + \beta_3 H + \beta_4 D + U$……..……………………………………………..(5)

Where;

Qd_s = quantity of seeds purchased in kg

P_s = price of seeds in Naira/kg

Y_s = producers income in Naira/season

H_s = land size devoted for legumes production hectare

D_s = distance to input market (source) in kilometer

$B_o – \beta_4$= Coefficients to be estimated

U = Noise term

Multiple Regression (fertilizer demand model)

$Qd_f = \beta_0 + \beta_1 P + \beta_2 Y + \beta_3 H + \beta_4 D + U$……………………………………………..(6)

Where;

Qd_f = quantity of fertilizer purchased in kg

P_f = price of fertilizer in Naira/kg

Y_f = producers income in Naira/season

H_f = land size devoted for legumes production hectare

D_f = distance to input market (source) in kilometer

$B_o - \beta_4$ = Coefficients to be estimated

U = Noise term

Multiple Regressions (Agrochemicals Demand Model)

$Qd_i = \beta_0 + \beta_1 P + \beta_2 Y + \beta_3 H + \beta_4 D + U$……………………………………………..(7)

Where;

Qd_i = quantity of insecticides purchased in kg

P_h = price of herbicides in Naira/kg

Y_h = producers income in Naira/season

H_h = land size devoted for legumes production hectare

D_h = distance to input market (source) in kilometer

$B_o - \beta_4$ = Coefficients to be estimated

U = Noise term

2.4.3 Binary Logistic Regression

The dependent variable for logit regression is binary taking a value of 1 and 0 for adopters and non-adopters of legumes production. This eventually expressed itself as:

$Y_i = \beta_0 + \beta_1 X_1 + U$………………………………………………………...(8)

The logistic cumulative probability function can be expressed as:

$P_I = E\ [Y = 1/X_I] = 1/1+e^{-(\beta_0\ \beta_1 X_1)}$ …………………………………………………..…(9)

For ease of expression, the above equation is written as:

$P_i = 1/1+e^{-Z} \quad = \quad e^Z / 1+e^{-Z}$ ………………………………………………………(10)

Where;

P_i = the probability that a farmer adopt maize-legume production system

$Z_I = \beta_0 + \beta_1 X_1 + \ldots\ldots\ldots\ldots + \beta_n X_n$

e = the base of the normal logarithms.

Although Z is a linear combination of variable that both upper and lower bound will be used as the variable Z. this is because the value of Z will depend on the value of the unknown parameters β_{is}. To obtain the value of Z, the likelihood of observing the sample will be found by introducing a dichotomous response variable Y. such that;

Y = 1 if farmer adopt maize-legume production system, 0 if otherwise and P ranges from 0 to 1.

P_i is not linearly related to Z_I (i.e. X_I), since P_i which is the probability of adopting maize-legume production system is given in equation 4 above.

Then (1 - P_i) the probability of non-adoption of maize-legume can be expressed as:

$1 - P_i = 1/1+e^{-Z}$ …………………………………………………………..............(11)

Therefore, we can rewrite:

$P_i / 1+e^{-Z} = 1+e^{-Z} / 1+e^{-Z} = e^z$ ……………………………………………………......... (12)

Taking the natural log of equation (5), this will be:

$Li = Ln\ [P_i / 1 - P_i] = Z_I = \beta_0 + \beta_1 X_1 + \ldots\ldots\ldots\ldots + \beta_n X_n$ …………………………….(13)

L = log of the odds ratio, not only in X but also in the linear parameter. It is called the logit or logit probability model. This implies that the logistic model explained in the equation is based on the logit of Z. The influence of a set of explanatory variable on adoption of maize-legume is specified using the following expression:

Adoption = f(X_1 X_2 X_3 X_4 X_5…………X_n)……………………………………………..(14)

Y = $\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_4 X_{4+} \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + U$…..............(15)

Y = Dichotomous response variable such that, Y = 1 if farmer adopts legume production system and 0 if otherwise

$B_0 – \beta_8$ = Coefficients to be estimated

U = Noise term

X_1 =Age (years)

X_2 =Farm size (hectare)

X_3 =Household size (numbers)

X_4 =Educational status (years)

X_5 =Years of experience (years)

X_6 =Income level (NGN)

X_7 =Contact to change agent (binary)

2.4.4 Gross Margin Analysis

Gross margin analysis was used to estimate profitability of legumes production. The gross margin model of legumes production system is expressed as follows:

GM= ∑YiPi - ∑XjPj…………………………………………………………………..(16)

Where

GM = Gross margin N/ha

$\sum$ = summation sign

Yi = quantity of output i

Pi = unit price of output i

Xj = unit cost of variable input j

Pj = quantity of variable input j

i and j = 1,2,3…….n

2.4.5 Multiple Regression Analysis (Input-Output Relationship)

Multiple regression analysis was used to determine input-output relationship in legumes production.

Model Specification

$K = f(X_1, X_2, X_3, X_4 \ldots Xn)$ …………………………………………………………..(17)

$K = P + \beta_1 QSD + \beta_2 FSZ + \beta_3 + \beta_4 TLB + \beta_5 FRT + \beta_6 CHE + \beta_7 MLB + U$ …………..........(18)

Where;

K= legume output (kg)

P = intercept

$\beta_1 - \beta_7$= Coefficient of the regressors

U = noise term

QSD =Quantity of seed (kg)

FSZ =Farm size (ha)

TLB =Total labour (mandays)

FRT =Fertilizer (kg)

CHE =Chemical (liter)

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 SOCIO-ECONOMIC CHARACTERISTICS OF GRAIN LEGUME FARMERS

Socio-economic characteristics of farmers are important human attributes that enhance the adoption of agricultural innovations. They also assist in getting the clear understanding of the behaviour of the farmers as well as providing a hint towards explaining their disposition that could improve their productivity (Ayinde, 2007).

The socio-economic variables identified for this research include gender, marital status, level of education, major occupation, age, household size, years of experience and income level of the farmers. The socio-economic variables are presented in Table 3a and 3b.

Table 3a: Socio-economic Characteristics Grain Legume Farmers

Variables	Project area (150)		Non-project area (150)	
	Frequency	Percentage	Frequency	Percentage
Gender				
Male	130	86.7	147	98
Female	20	13.3	3	2
Marital status				
Married	142	94.7	145	96.7
Single	3	2.0	1	0.7
Widow	3	2.0	2	1.3
Divorced	2	1.3	2	1.3
Educational status				
Non-formal education	63	42	70	46.7
Primary education	41	27.3	38	25.3
Secondary education	35	23.3	21	14
Tertiary education	11	7.3	21	14
Major source of income				
Farming	117	78	118	78.7
Civil service	11	7.3	17	11.3
Livestock rearing	12	8	4	2.7
Trading	10	6.7	11	7.3
Cooperative membership				
Member	145	96.7	142	94.7
Non-member	5	3.3	8	5.3
Land ownership				
Inherited	133	88.7	136	90.7
Purchased	16	10.7	12	8
Rented	1	0.7	2	1.3

Source: Field survey, 2015

4.1.1 Gender of Grain Legume Farmers

Gender is defined by FAO as ‘the relations between men and women, both perceptual and material. It is a central organizing principle of societies, and often governs the processes of production and reproduction, consumption and distribution’ (FAO, 1997). Descriptive statistics presented in Table 3a indicated that legume production is dominated by male both in project and non-project areas. This is clearly seen as 86.7% farmers in the project area and 98% farmers in the non-project area are male. This might be related to the believe that male bear family responsibility as bread winners while female are traditionally expected to perform domestic work especially in rural areas. Female participation on legume production in the project area is greater than that of non-project area. This is in conformity with requirement of N2Africa legume technology were introduced based on gender consideration.

4.1.2 Marital Status of Grain Legume Farmers

Marital status to some extent influences the size of the farmers' family and availability of labour for farm production because the marriage institution poses some restrictions as regards which member of the family should practice farming (Victor, 2004). It can be seen clearly from Table 3a that majority of the farmers in the project area were married (94.7%) while only very few are single and widow (7%) respectively. It can also be noted that majority (96.7%) of the farmers in the non-project area were also married. This may not be contrary to the tradition in typical Hausa/Fulani community like Kano state where marriage is considered as a symbol of respect and can increase household size. Marriage is considered important for matured people in the African setting (Adebayo, 2010).

4.1.3 Educational Status of Grain Legume Farmers

Trichopoulou, 2002, defined education as 'the wealth of knowledge acquired by an individual after studying particular subject matter or experiencing life lessons that provide an understanding of a particular thing. Descriptive statistics presented in Table 3a revealed that 42% farmers have non-formal education while majority had one kind of formal education or another (i.e primary, secondary or tertiary) in the project area. The same is applied for non-project area as 46.7% had non-formal education while 53.3% farmers had formal education. Farmers' formal education may increase their ability to understand agricultural innovations which might subsequently increase their production.

4.1.4 Major Source of Income

Occupations of the population are largely influenced by the setting of their environment as well as their local economy as is often the case in most rural Africa and Nigeria in particular where livelihood strategies usually involve mixture of activities including farm and off-farm employment (IFAD, 2009). The result in Table 3a revealed that majority of the farmers both in project and non-project areas had farming as their major source of income. Findings also revealed that only 7.3% farmers in the project area had civil service as their major source of income while 11.3% farmers from non-project area had civil service as their major income source. Trading as indicated by 6.7% farmers in the project area was the major source of income. This result goes in line with findings of Isah, Adebayo, Muhammad and Offar (2013) in their paper titled profitability of sole cowpea production in Gombi Zone of Adamawa State.

4.1.5 Cooperative Membership

Association is a form when individuals recognize common and desirable needs among themselves (Olukosi, 2007). Descriptive statistics in Table 3a shows that majority (96.7%) of the farmers in the project area members of cooperative organization while only 3.3% of the farmers are not members of any cooperative organization. Also 94.7% farmers as majority in non-project area are members of one cooperative organization or another. Membership of cooperative organisation can offer certain benefits to members such as input procurement, information on output market and subsidy.

Table 3b: Socio-economic Characteristics Grain Legume Farmers

Variables	**Project area (150)**			**Non-project area (150)**	
	Frequency	**Percentage**	**variables**	**Frequency**	**Percentage**
Age (yrs)					
22 – 31	6	4	30 – 40	38	25.3
32 – 41	29	19.3	41 – 50	63	42.0
42 – 50	68	45.3	51 – 60	37	24.7
51 – 60	41	27.3	61 – 70	10	6.1
61 – 70	6	4	71 – 80	2	1.3
Minimum		22			30
Maximum		70			80
Mean		47.2			47.7
Household size(No.)					
2 – 6	79	52.7	1 – 6	43	28.7
7 – 12	52	34.7	7 – 12	60	40.0
13 – 16	16	10.7	13 – 18	34	22.7
17 – 20	2	1.3	19 – 24	6	4.0
21 – 24	1	0.7	25 – 30	7	4.7
Minimum		2			1
Maximum		1			30
Mean		6			11
Farm size(ha)					
0.5 – 1.8	51	34	0.5 – 1.4	18	12
1.9 – 3.1	73	48.7	1.5 – 2.3	49	32.7
3.2 – 4.4	20	13.3	2.4 – 3.2	53	35.3
4.5 – 5.7	5	3.3	3.3 – 4.1	26	17.3
5.8 – 7.0	1	0.7	4.2 – 5.0	4	2.7
Minimum		0.5			0.5
Maximum		7			5
Mean		2.2			2.59
Farming experience(yrs)					
5 – 16	30	20	5 – 15	31	20.7
17 – 27	38	25.3	16 – 25	47	31.3
28 – 38	51	34	26 – 35	35	23.3
39 – 49	28	18.7	36 – 45	28	18.7
50 – 60	3	2	46 – 55	9	6.0
Minimum	5				5
Maximum	60				55
Mean	27				26.9

Source: Field survey, 2015

4.1.6 Ownership Structure of Land

Majority (88.7% and 90.7%) of the farmers in project and non-project areas respectively acquire their land through inheritance. In project area, 10.7% farmers acquire land through purchase while only 0.7% farmers rent land for production purpose. However, in non-project area 8% farmers acquire land through purchase while only 1.3% farmers acquire land through renting. This shows that, inheritance is the major source of land acquisition by grain legume farmers and this is in conformity with findings of Kakwang (2011)

4.1.7 Age of Grain Legume Farmers

Age refers to the number of years a person has lived. It is the length of time that a person has lived or existed. It explained the years of the farmer at the time of the study. Descriptive statistics in Table 3b revealed that majority (64.6%) of the farmers in the project area falls within age bracket of 31 – 50 while 27.3% farmers falls between age bracket of 50 – 60 respectively. In non-project, 67.3% legume farmers falls within age bracket of 30 – 50 while 24.7% farmers falls within age bracket of 51 – 60. This is an indication that majority of the farmers both in project and non-project area falls within their active age. This might give grain legume farmers the opportunity for participation in legume production which may results to increase sustainability of legumes production.

4.1.8 Household size of Grain Legume Farmers

Household size refers to the total number of individuals who live within and feed from the same pot. According to the National Population Commission (NPC, 2006), these individuals think of themselves as a unit. According to Ogunbile, (2002), household size is the total number of individuals who live within and feed in the same house. Descriptive statistics in Table 3b revealed that 52.7% farmers in the project area had household size of 2 – 6 members while 34.7%) farmers had house hold size of 7 – 12. Only 1.3% farmers in project area had house hold size of 17 – 20. In non-project area, 40% farmers had house hold size between 7 – 12 while 28.7% farmers had house hold size between 1 – 6 members. The mean household size is 6 and 11 for project and non project area respectively. This shows that legume farmers had responsibility of feeding their dependent which might increase household expenses and on the other hand might provide labour for the farming families.

4.1.9 Farm Size of the Farmers

Olayide (1982), reports that majority of Nigerian farmers were usually small-scale farmers. Result in Table 3b shows that majority (48.7%) of the farmers in the project area falls within farm size bracket of 1.9 – 3.1 while only 0.7% legume farmers had more than 5 hectare of land. In non-project area, 32.7% legume farmers falls within farm size of between 1.5 – 2.3 while only 2.7% farmers falls within 4.2 – 5.0 hectare. The mean of the farm size in the project area is 2.2 while in non-project area, the farm size mean is 2.59. This shows that legume farm size of the legume farmers might be sufficient for legumes production both family and commercial purposes.

4.1.10 Farming Experience of Grain legume Farmers

Descriptive statistics in Table 4 revealed that 34% farmers had farming experience of 28 – 38 years while only 2% had farming experience between 50 – 60 years in the project area. In non-project area, 31.3% had farming experience between 16 – 25 years while only 6% had farming experience between 46 – 55 years. Stanger, (2000) stressed a positive relationship exists between years of experience in business and its performance.

The mean farming experience was 27 and 26.9 for project and non project area. Farming experience might help farmers with vital information for increased legume production.

4.2 Factors That Influence Input Demand among Smallholder Farmers

Determinants of inputs demand among smallholder farmers were analyzed using multiple regression analysis. The dependent variable included in the model is the quantity of particular input (i.e fertilizer, improved seeds and chemicals) while the repressors include price of input in naira, producers annual income, land size (ha) and distance to input source (km). Table 4 below presents the multiple regression analysis for determinants of inputs demand both in project and non-project area.

Table 4: Multiple Regression Analysis for Determinants of Input Demand

Variables	**Project area (150)**						**Non-project area (150)**					
	Fertilizers		**Seeds**		**Chemicals**		**Fertilizers**		**Seeds**		**Chemicals**	
	Coeff.	**t-value**	**Coeff.**	**t-value**	**Coeff.**	**t-value**	**Coeff.**	**t-value**	**Coeff.**	**t-value**	**Coeff.**	**t-value**
Price of inputs(NGN)	-246.02	-2.145**	-0.532	-3.106**	0.000	0.593n	-0.013	-0.156*	-0.0301	-0.430n	0.000	0.145n
Farm size (ha)	107.22	5.564*	0.313	2.353**	0.057	0.906n	8.553	1.613n	0.014	0.371n	-0.007	-0.21*
Annual income(NGN)	81.19	4.57*	0.616	5.025*	3.057E-06	3.482*	0.000	-2.156n	0.260	1.049n	1.104E-06	1.185n
Distance to market (km)	-32.03	-3.72*	0.208	3.721*	-0.017	-0.041n	-0.062	-0.005n	-0.008	-0.289*	-0.005	-0.961*
Constant	132.4n	0.558	-1.261	-1.71*	0.224	0.261	135.25	4.484	2.041	6.648	-0.023	-0.030
R^2	32%		47%		44%		37%		49%		48%	
R^2 adjusted	29.3%		45%		35%		32.4%		39%		39.2%	
F-value	42.91		15.77		16.11		14.31		10.33		17.52	

Source: Field survey, 2015 *=10% significant, **= 5% significant, n=not significant

The variables included in the multiple regression analysis for determinants of inputs demand include price of inputs, farm size (ha), average annual income and distance to input source (km) respectively. The result of regression in Table 4 revealed the R^2 is 32%, 47% and 44% for fertilizer, seeds and chemical demand in project area while non-project area result revealed R^2 of 37%, 49% and 48% for fertilizer, seeds and chemical respectively. This means that 32%, 47%, 44% and 37%, 49%, 48% of variations in soybean, cowpea and groundnut as dependent variables in project area and non-project area were explained by the independent variables included in the model. In project area with respect to fertilizer, the coefficients of farm size and annual income were found to be positive and significant at 1% level of significance. This means that unit increase in farm size and annual income leads to an increase in the quantity of fertilized purchased among legume farmers. Assa M. *et-al* (2014) reported that increase in farm size and annual income of smallholder farmers leads to an increase in quantity of fertilizer use in production. The coefficient of price and distance to input source were negative and significant at 5% and 1% respectively. This means that, increase in price of fertilizer leads to decrease in quantity demanded. Similarly, increase in distance to input source leads to decrease in quantity demanded of fertilizer. Farmers use portion of their income for payment of transportation when distance increases which ultimately decreases quantity of fertilizer purchase.

With respect to seed in project area, the coefficients of farm size and annual income were positive and significant at 1% level of significance. This means that increase in farm size and annual income of smallholder farmers leads to increase in quantity demanded of fertilizer. As farm size and annual income of the farmers' increases, it is possible for farmers to increase quantity of seed in their production. This is in line with the findings of Alimi (2000), where he stated that inadequate financial capital could impede the performance of farming activities and also affect the use of agricultural inputs. However, coefficients of price were negative and significant at 1%, meaning that increase in price of fertilizers reduces quantity demanded proportionately. In non-project area with respect to seeds, the coefficient of farm size and annual income were positive and non significant while coefficient of distance to input were negative but not significance hence no explanation is needed. Coefficients of seed price were negative and significant at 5% meaning that, increase in price of seeds leads to decrease in quantity purchase.

With respect chemicals in project area, the coefficient chemical price and farm size were positive and not significant while coefficient of distance to agrochemical source were negative and also not significant. In addition, the coefficient of annual income were tested positive and significant at 1%, meaning that as farmers annual income increases, the quantity of chemicals demanded also increases. This is true as summary of statistics for variables used in legume production revealed price of agrochemicals as relatively high. In the control site, the result indicates that, coefficient of price and annual income were positive and non significant while coefficient of distance to chemical source were negative and also not significant. However, the coefficient of farm size were negative but significant at 10% meaning that as farm size increases, the quantity demanded of chemicals and other inputs among legume farmers decreases. This is probably due to expensive nature of agrochemicals to the extent that farmers income cannot satisfy the chemical requirement of large area of land. The distance to the nearest market has some influence on farmers' production decisions and adoption of agricultural technologies.

4.3 Adoption and Factors Influencing Adoption of Grain Legumes

Table 5, 6 revealed distributions of farmers based on awareness, adoption, adoption score while Table 7 revealed logit regression result of factors influencing adoption of grain legumes

Table 5: Adoption of Grain Legumes Technology among farmers (n=150)

Variables	Frequency	Percentage
Adopters	135	90
Non-adopters	15	10
Total	150	100

Source: Field survey, 2015

Table 5 revealed adoption of grain legumes technology. In addition, 135 farmers equivalent to 90% adopted the technologies while only 15 farmers representing 10% do not adopt the legume production. The result also indicated that majority (90%) of the farmers belongs to adopters category of grain legumes production.

Table 6: Adoption Score of N2Africa Legumes Production Technology (n=150)

Adoption stages	Improved seeds	Inoculants	Fertilizers application	Spacing	Agro-chemical application
Awareness	100	100	100	100	100
Trial	94.4	0	88	74.67	58
Adoption	90	0	80.67	88.6	0.28
Totals	377	100	353	330	217
Adoption score	0.86	0.22	0.78	0.77	0.48
Grand mean adoption Score: 0.68					

Source: Field survey, 2015

Table 6 shows distribution of farmers based on adoption of N2Africa legumes technologies. The highest adoption score was 0.84 for planting of improved legume seeds introduced by N2africa. The lowest adoption score was 0.22 for inoculants application because the inoculants are not readily available in the market for farmers to purchase. The grand mean adoption score was 0.68; meaning that 68% of the entire N2Africa legumes production technology was adopted by contact farmers in the study area.

4.3.3 Factors Influencing Adoption of Grain Legumes in the Study Area

Socioeconomic factors influencing adoption of grain legumes in the study area was analyzed. The variables included in the analysis includes age, farm size, marital status, household size, educational status, farming experience, annual income and contact with extension agents. Table 7 below gives summary of the logistic regression result.

Table 7: Logit Regression of Factors Influencing Adoption of Legumes Production (n=150)

Independent variable	B	S.E	Wald	Df	Sig	Exp(B)
Age (years)	0.039	0.048	0.685	1	0.408	1.040
Farm size (ha)	0.126	0.448	0.079	1	0.778	1.134
Household size(No.)	-0.264	0.141	3.496	1	0.062**	0.768
Educational status (years)	1.325	0.685	3.746	1	0.053**	3.764
Farming experience(years)	0.122	0.049	6.158	1	0.013*	1.130
Annual income (NGN)	0.000	0.000	6.846	1	0.009*	1.000
Extensionist contact(Dummy)	-21.172	2290.9	0.000	1	0.999	0.000
Constant	13.924	2290.9	0.000	1	1.000	11114.8

Source: Field survey, 2015 *=5%significant, **=10% significant

$\chi^2 = 51.761$ df = 8

Pseudo $R^2 = 0.292$ (Cox and Snell)

Pseudo $R^2 = 0.612$ (Nagelkere)

-2 log likelihood = 45.764

Dependent variable: Adoption of grain legumes

The logistic regression result as shown in Table 7 suggest that the statistical parameters that indicate “goodness of fit” of the model specified for this study are highly significant at 5% level of probability. Thus the chi-square (χ^2) of 51.761 with a degree of freedom (df) respectively indicate support for the model, implying that the model containing the intercept and the independent variables is accepted. Additionally, the pseudo R^2 statistics of 0.292 and 0.612 suggested that between 29.2 and 61.2 percent variance observed in the model is attributed to the independent variables. Mean while, the result summary in Table 16 which gives information on the contribution of each of the independent variables suggest that educational status, farming experience, annual income and household size are statistically significant at 5% level of probability. Based on the result, increase in literacy level will most likely result in an increased farmer's level of adoption of N2Africa legume technology. This is in conformity with findings of Imoh and Essien (2005) who reported that farmers' level of education influence adoption of technology positively. This is possible as education is an investment in human capital which is able to raise the skills and qualities of man, narrow his information gap and increase his allocative abilities thereby leading to more production performance. Chukwuji (2006) reported that education influences the adoption of practice in modern Agriculture.

Farming experience was also significant. The positive relationship between years of experience and adoption implied that adoption of improved technologies tended to be accepted by experienced farmers as they understand the importance of technologies in farming. This result goes in line with findings of Bello M. *Et-al* (2011) as they discover farming experience as variable that influence adoption of agricultural innovations. The more the farmers have experience on farming practice the more likely they understand, accept and adopt new innovations and vice versa. Age, in correlation with farming experience, has a significant influence on the decision-making process of farmers with respect to risk aversion, adoption of improved agricultural technologies, and other production related decisions (Amaza, 2007; 2009).

For annual income, the income of the farmers help them to purchase productive inputs as most of the innovations left farmers after demonstration with responsibility of inputs provision for the purpose of sustainability. Positive relationship between income and adoption implied availability of income which enhances farmers' ability to purchase the inputs embodied in the new technology and pay for hired labour needed for the use of these inputs and improved management practices for greater productivity. (Bello, 2011)

With respect to significant of household size, it is possible that increase in household size may lead to an increase in provision of labour requirement for the farming families. The number of adult male and female as well as male and female child have greater role to play through participation at various stage of production and this leads to decrease particularly expenditure on hired or paid labour.

4.4 Average Costs and Returns Analysis of Legumes Production

Costs and returns analysis of legume production system were carried out using farm budgetary techniques. The analysis were made for both project and non-project areas. The analysis focuses on three major legumes (soybean, cowpea and groundnut) which are the mandate crops for N2Africa in Nigeria. Table 8 below presents the cost and return analysis of legume production in the study area.

Table 8: Profitability Analysis of Legumes Production

Variables	Project area (150)						Non-project area (150)					
	Soybean		Cowpea		Groundnut		Soybean		Cowpea		Groundnut	
	Cost(N/kg)	%	Cost(N/kg)	%	Cost(N/kg)	%	Cost(N/kg)	%	Cost(N/kg)	%	Cost(N/kg)	%
1. Cost												
Seeds (kg)	4725.42	6.37	3819.78	5.17	4304.89	5.84	5742.40	7.25	4734.11	6.14	6765.22	8.27
Fertilizers (kg)	10715.00	14.45	11615.56	15.73	13255.56	17.99	7047.50	8.90	9203.33	11.94	11328.89	13.85
Agrochemicals (litre)	1531.00	2.07	1299.78	1.76					1125.56	1.46		
Organic manure (kg)			588.89	0.80					1384.44	1.80		
2. labour (mandays)												
Land preparation	17292.50	23.32	14313.33	19.39	13663.33	18.54	20219.17	25.52	17333.33	22.48	18524.44	22.65
Planting	4214.17	5.68	4625.56	6.26	4114.44	5.58	4726.00	5.97	4926.67	6.39	4708.89	5.76
Fertilizer application	1851.00	2.50	1771.11	2.40	2738.89	3.72	1941.67	2.45	2244.44	2.91	2071.11	2.53
Weeding	17573.33	23.70	18533.73	25.10	18546.67	25.16	19223.73	24.27	18888.89	24.50	19880.00	24.31
Harvesting	16253.33	21.92	17271.11	23.39	17080.00	23.17	20319.17	25.65	17248.89	22.38	18513.33	22.64
Total variable cost (TVC)	74155.75		73838.85		73703.78		79219.64		77089.66		81791.88	
3. Returns												
Average yield (kg/ha)	1668.62		1506.67		1388.67		1052.50		1124.44		793.33	
Average price (₦/kg)	120.07		129.22		107.33		124.70		127.11		111.67	
Gross revenue (₦/ha)	200351.20		194691.90		149045.95		131246.75		142927.57		88591.16	
Gross margin (GR - TVC)	126195.45		120853.05		75342.17		50027.11		65837.91		6799.28	
Return to ₦ invested	1.70		1.64		1.02		0.66		0.85		0.08	

Source: Field survey, 2015

The variables cost components considered in the average cost and return analysis include seeds, fertilizers, agrochemicals, organic manure, land preparation, planting, fertilizer application, weeding and harvesting. The differences in the total variable cost production between project and non-project farmers were attributed to the differences in cost of inputs and labour in the two sites. Average cost and returns analysis in Table 8 shows that labour accounted for greater part of the total variable cost incurred in both intervention and the control site. Labour cost in project and non-project area were represented by 77.12% and 83.86% for soybean, 76.54% and 78.66% for cowpea while labour cost of groundnut were represented by 76.17% and 77.89% respectively. This is as a result of differences in location as labour cost differ from one community to another. The average price in project and non-project area was N120.07/kg and N124.70/kg for soybean, N129.22/kg and N127.11/kg for cowpea while groundnut average price was found to be N107.33/kg and N111.67/kg in project and non-project area respectively. These prices were used in estimating the revenue which form the basis for computation of gross margin which measures the economic performance of enterprises in the two sites.

The analysis in Table 9 revealed that, the total cost of cultivating one hectare of soybean was N74155.75 with gross revenue of N200351.20, thus making a gross margin of N126,195.45 while non-project site shows a total production cost of N79,219.64 with gross revenue of N131,246.75 thus making a gross margin of 52,027.11 respectively. This shows that, soybean farmers in project area has higher gross margin compared to the farmers from non-project area. The highest gross margin obtained by project farmers can be attributed to the adoption of N2Africa technologies in the project site while low gross margin in non-intervention area implies farmers are still using local technologies.

However, the total cost of production for cowpea farmers in project area was N73838.85 and gross revenue of N194691.22 with a gross margin of N120853.05 while non-project area cowpea farmers had total cost of production of N77089.66 and gross revenue of N142927.57 with gross margin of N65837.91 respectively. This finding goes in line with work of Usman and Fatima, (2014) who reported that cowpea production is profitable among smallholder farmers in Zaria local government, Nigeria. This result also indicate higher gross margin of cowpea in project area compared to non-project area. This result is similar to the findings of Isah, Adebayo, Muhammad and Offar (2013) that, cowpea production among smallholder farmers in Nigeria in profitable. With respect to groundnut enterprise, the gross margin analysis show the total cost of production for project farmers was NGN73703.70 and gross revenue of NGN149045.95, thus making a profit/gross margin of NGN75342.17 while for non-project farmers, the total cost of production was NGN81791.88 and gross revenue of NGN88.591.16 with a gross margin of 6799.28 respectively. The analysis further shows more return to Naira invested in project than non-project area for soybean, cowpea and groundnut enterprise. Generally, the gross margin analysis of the two sites shows N2Africa technologies play vital role in increasing smallholder farmers' productivity. Improved legume seeds, fertilizers and special production techniques particularly planting, spacing and fertilizers application were provided by N2Africa in the project area making farmers to realize higher output and profit.

4.5 Input-Output Relationship of Legume Production

Input-output relationship of legume production was analyzed using multiple regression. The variables were the quantity of soybean, cowpea and groundnut output respectively while the independent variables were fertilizer, quantity of seeds, hired labour, farm size, herbicides, pesticides and family labour. The analysis were made for both project and non-project area. Table 9 below presents the input-Output Relationship of Legume Production System.

Table 9: Regression Result for Input-Output Relationship of Legumes Production

Variables	Project area (150)						Non-project area (150)					
	Soybean		Cowpea		Groundnut		Soybean		Cowpea		Groundnut	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Quantity of seed (kg)	-0.062	-0.025ns	-15.252	-2.21**	-0.024	-0.27ns	23.176	15.33*	21.159	15.65*	19.351	10.33*
Quantity of fertilizer	8.145	12.65*	12.634	13.70*	0.932	9.838*	-0.841	-1.78***	-0.187	-0.62ns	0.611	1.95***
Total labour (mandays)	-1.539	-0.65ns	1.104	1.217ns	0.247	1.656ns	1.393	1.357ns	-0.627	-0.85ns	-0.702	-0.43ns
Farm size (ha)	91.945	3.006**	2.210	0.054ns	-0.029	-1.34ns	42.528	1.245ns	25.681	1.045ns	-0.104	-1.28ns
Constant	654.10	2.308**	-143.5	-0.14ns	0.630	1.64ns	-325.18	-1.98***	80.826	0.636ns	-79.033	0.34ns
R^2	77.4%		84%		74.9%		82.9%		86.4%		74.4%	
R^2 adjusted	75.7%		82.4%		72.4%		81.7%		85.1		71.9%	
F-value	47.07		53.33		29.16		66.70		63.66		29.13	

Source: Field survey, 2015 *=10% significant, **= 5% significant, *** 1% significant, ns=not significant

The variables included in multiple regression analysis for input-output relationship in legume production include quantity of seeds (kg), quantity of fertilizer (kg), amount of labour (mandays) and farm size (ha). Multiple regression result in Table 9 revealed R^2 of 74.4%, 84%, 74.9% for soybean, cowpea and groundnut in project area while non-project area result shows R^2 of 82.9%, 86.4% and 74.4% for soybean, cowpea and groundnut enterprise respectively.

For soybean production in project area, the coefficient of fertilizer and farm size were positive and significant at 1% and 5% level of significance. This result conforms to findings of Olurasanya, (2009) as discovered that, farm size has a significant positive contribution in soybean production. This means that, increase in fertilizer and farm size leads to a proportionate increase in soybean output among smallholder farmers in the project intervention area. In non-project area, coefficients of seed were positive and significant at 1% level of probability. This shows that, a unit increase in seeds leads to a corresponding increase in soybean output and this goes in line with findings of Olurasanya, (2009). Also unit increase in fertilizers reduces soybean output. This result shows element of fertilizer over utilization among soybean farmers in non-project area. Coefficient of labour and farm size were positive but not significant, hence doesn't require further explanation.

With respect to cowpea in project area, the coefficient of seed was negative and significant at 5% level of probability while coefficients of fertilizer were positive and significant at 1% level of probability. This result is similar to the work of Adeola, (2009) where fertilizer and seed was found to have a significant and positive contribution in cowpea production. This means increase in quantity of seed leads to decrease in cowpea output while unit increase in quantity of fertilizer result to an increase in cowpea output. In non-project are, the coefficient of farm size were positive and not significant while coefficient of seed quantity is positive and significant at 1% level of probability. This means increase in seed result to increase in cowpea output.

With respect to groundnut in project area, coefficient of fertilizer was positive and significant at 1% level of probability. This result shows that, unit increase in quantity of fertilizer result to increase in groundnut output among farmers in the project area. This result conforms with findings of Taphee, and Jongur (2014) that a unit increase in fertilizer leads to increase in groundnut output. The coefficient of seed and farm size were negative. Similarly in non-project area, quantity of fertilizer has a positive coefficient that is significant at 10% level of probability which means unit increase in quantity of fertilizer leads to increase in groundnut output. Usman and Fatima (2014) also reported that fertilizer increase in legume production has a positive and significant influence.

4.6 Constraints Militating Input Demand and Adoption of Legumes Technology

This component present constraints militating against input demand and adoption of N2Africa grain legumes technology. The constraints are presented in Table 10 and 11 below:

4.6.1 Constraints Militating Input Demand among Smallholder Farmers

Table 10 presents the constraints associated with input demand/supply among smallholder legume farmers in the study area. The problems identified includes lack of inoculants, high cost of fertilizers, improved seeds, and agro-chemicals, non-availability of some inputs, problems of quality inputs, behaviour of middlemen, high distance to input source, frequent price increase, low information on price and source of inputs and lastly late arrival of fertilizers. Table 10 below presents summary of the constraints for both project and non-project area.

Table 10: Constraints Militating Input Demand among Smallholder Farmers

Constraints	Project area (150)			Non-project area (150)		
	Frequency	%	Ranking	Frequency	%	Ranking
Lack of inoculants	150	100	1st	...	...	...
High cost of fertilizers	98	65.3	2nd	70	46.7	2nd
High cost of improved seeds	69	46	3rd	89	59.3	1st
High cost of agro-chemicals	40	26.7	7th	48	32.7	5th
Non-availability of inputs	30	20	8th	34	26.7	6th
Problems of quality inputs	29	19.3	9th	19	12.7	9th
Behaviour of middlemen	44	29.3	6th	63	42	3rd
High distance to input source	52	34.7	4th	15	10	7th
Frequent price increases	21	14	10th	33	22	8th
Low information (price/source)	11	7.3	11th	18	12	10th
Late arrival of fertilizers	51	34	5th	53	35.3	4th

Source: Field survey, 2015

Statistics from Table 10 revealed that lack of inoculants ranked first. This is due to non availability of inoculants in the market. Majority of the farmers in project and non project area consider high cost of fertilizer as constraint and ranked second among the major problems. This is due to similarity in increase of fertilizer prices across the state. High cost of improved seeds was ranked third in project area and first in non project area. This is due to many projects promoted and farmers' awareness on different sources on improved seed in the project area. Late arrival of fertilizers was ranked 5th and 4th in project and non project area respectively. This is clear as late fertilizer disbursement to farmers has been recorded. Distance to input source was ranked 4th in project area while 7th in non project area. This is due to high distance of the project area especially Doguwa and Tudun wada which make farmers accessibility to inputs difficult. Low information on price and source of inputs was ranked last the problem. This is due to farmers participation in cooperative and group activities in project and non project area.

4.6.2 Constraints Militating Against Adoption of Grain Legumes Production

Farmers both in project area identified problems with regards to grain legume production. The major problems identified includes attack of pest and diseases, fragmented land holdings, drought problems, attack by pastoralists, low production training, high cost of labour and lastly low market price of output. Table 11 presents statistics of the constraints militating against adoption of grain legume production of N2Africa in Kano state.

Table 11: Constraints Militating Against Adoption of Grain Legumes Production (n=150)

Problems	Frequency*	Percentage	Ranking
Attack of pest and diseases	94	62.7	1st
Fragmented land holdings	44	29.3	5th
Drought problems	91	60.7	2nd
Attack by pastoralist	27	18	6th
Low production training	19	12.7	7rd
High cost of labour	56	37.3	4th
Low market price of output	89	59.3	3th

Source: Field survey, 2015 *(multiple response)

Descriptive statistics from Table 11 revealed that attack of pest and diseases were ranked first (62.7%) while drought problems were ranked second (60.7%) for both project and non project areas respectively. Pest and diseases might cause serious damage to legumes which might subsequently decrease farmers productivity. Project area farmers ranked low market price of output as third (59.3%) major constraint. This is due to accessibility problem to market and probably bulkiness during harvest resulting to market glut. Low training on production techniques of legumes was ranked the last (12.7%) constraint among farmers in the project area. This is might be possible as farmers receive pre-season training on legumes production especially planting rate, spacing, fertilizer requirement and application.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

The research analyzed determinants of inputs demand and adoption of grain legumes and associated technologies of N2Africa in Kano state. Multi-stage sampling techniques consisting purposive and random sampling were used in selection of 150 farmers each from project and non-project area making a sample size of 300 farmers for the study. Descriptive statistics of the farmers revealed that majority both in project and non-project areas possess similar socio-economic characteristics in terms of gender, age, marital status, educational status, major source of income and ownership structure of land except annual income, distance to input source and household size respectively. There were also element of similarity between project and non project areas in terms of contact with extension agents, awareness on input dealers and source of market information.

Multiple regression result in Table 5 revealed the R^2 is 32%, 47% and 44% for fertilizer, seeds and chemical demand in project area while non-project area result revealed R^2 of 37%, 49% and 48% for fertilizer, seeds and chemical respectively. This means that 32%, 47%, 44% and 37%, 49%, 48% of variations in soybean, cowpea and groundnut as dependent variables in project area and non-project area were explained by the independent variables included in the model. In project area with respect to fertilizer, the coefficients of farm size and annual income were found to be positive and significant at 1% level of significance. This means that any increase farm size and annual income leads to an increase in the quantity of fertilizer. The coefficient of price and distance to input source were negative and significant at 5% and 1% respectively. This means that, increase in price of fertilizer leads to decrease in quantity demanded.

The gross margin analysis revealed that, the total cost of cultivating one hectare of soybean was N74155.75 with gross revenue of N200351.20, thus making a gross margin of N126,195.45 while non-project site shows a total production cost of N79,219.64 with gross revenue of N131,246.75 thus making a gross margin of 52,027.11. However, the total cost of production for cowpea farmers in project site was N73838.85 and gross revenue of N194691.22 with a gross margin of N120853.05 while non-project cowpea farmers had total cost of production of N77089.66 and gross revenue of N142927.57 with gross margin of N65837.91. groundnut enterprise, the gross margin analysis show the total cost of production for project farmers was n73703.70 and gross revenue of N149045.95, thus making a profit/gross margin of N75342.17 while for non-project farmers, the total cost of production was N81791.88 and gross revenue of N88.591.16 with a gross margin of 6799.28 respectively.

The variables included in multiple regression analysis for input-output relationship in legume production include quantity of seeds (kg), quantity of fertilizer (kg), amount of labour (mandays) and farm size (ha). Multiple regression result revealed R^2 of 74.4%, 84%, 74.9% for soybean, cowpea and groundnut in project area while non-project area result shows R^2 of 82.9%, 86.4% and 74.4% for soybean, cowpea and groundnut enterprise respectively. For soybean production in project area, the coefficient of fertilizer and farm size were positive and significant at 1% and 5% level of significance. With respect to cowpea in project area, the coefficient of seed was negative and significant at 5% level of probability while coefficient of fertilizer was positive and significant at 1% level of probability. In non-project are, the coefficient of farm size were positive and not significant while coefficient of seed quantity is positive and significant at 1% level of probability. This means increase in seed result to increase in cowpea output. However, the coefficient of labour and fertilizer were negative but not significant at all level of probability.

The logistic regression result suggest that the statistical parameters that indicate "goodness of fit" of the model specified for this study are highly significant at 5% level of probability. Thus the chi-square (χ^2) of 52.07 with a degree of freedom (df) respectively indicates support for the model, implying that the model containing the intercept and the independent variables is accepted. Mean while, the result summary of logit regression result which gives information on the contribution of each of the independent variables suggest that educational status, farming experience, annual income and household size are statistically significant factors influencing adoption of legumes technology while farm size, contact to change agents and age were not significant. Major constraints faced by farmers with respect to input demand includes lack of inoculants, high cost of fertilizers, improved seeds and agro-chemicals, non-availability of inputs, problems of quality inputs, behaviour of middlemen, high distance to input source, frequent price increase, low information (price/source), late arrival of fertilizers. Constraints militating legumes production includes attack of pest and diseases, drought problems, attack by pastoralist and low production techniques training.

5.2 Conclusion

The study concluded that both project and non-project area share element of similarities in terms of some socio-economic variables. The study also concluded that, increase in prices of agricultural inputs especially fertilizer, agrochemicals and to some extent seeds result to decrease in quantity of those inputs purchased by farmers. Distance to input source has a negative effect on quantity of inputs purchased by smallholder farmers particularly in project area. Farm size and annual income of smallholder farmers also has relative influence on quantity of inputs especially seeds and fertilizers.

It was also concluded that legume production is profitable but the gross margin in project area is higher compared to non-project area. Based on this, legume farmers in project intervention area have greater annual legume return hence having higher annual returns from legume enterprise.. This higher output that leads to higher return could be attributed to adoption of N2Africa technologies among project farmers. There is complete absence of inoculants across both project and non-project area. Despite the profit obtain from legume enterprises, farmers are faced with certain inputs related problems which include high cost of inputs, non-availability of inputs, late arrival of inputs and high distance to input source. Major problems affecting legume production includes attack of pest and diseases, drought problems, in adequate production training and high cost of labour.

5.3 Recommendations

Based on the findings of this study, the following recommendations are suggested:

1. There is the need for sustainable input supply policy that will ensure availability, affordability and timely delivery of agricultural inputs for better legume production in the study area.
2. Creation of public and private small and medium inputs outlets (enterprises) to cut the impending distance that militate against farmers’ access to input is also important in the study area.
3. Farmers should be encouraged to produce legume through special and adequate training on production techniques of legumes including proper disease and pest management for efficient productivity.
4. Planting of drought resistance legume varieties is also essential among grain legume farmers in the study area.

5. Dialogue between gain legumes farmers and pastoralist should be promoted to resolve the existing complicit in the affected areas.
6. Farmers should be encouraged to form cooperative societies to pool their resources together to enable them to have access to improved farm inputs and to enhance the accessibility to agricultural information and inputs.
7. Extension agents should enlighten farmers on proper farm resources allocation and management especially efficient utilization of labour resources and fertilizers.
8. Investment in physical infrastructure, such as roads and modern markets facilities is very essential. With respect to roads, rural feeder roads that link input and output markets to farmers should be provided.
9. Market identification before production is also important among grain legume farmers.

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DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION

FACULTY OF AGRICULTURE

BAYERO UNIVERSITY KANO

RESEARCH QUESTIONNAIRE

Dear Respondent;

I am a student of the above named institution from Department of Agricultural Economics and Extension, Faculty of Agriculture conducting research on a topic titled **“Determinants of Inputs Demand and Adoption of Grain Legumes and Associated Technologies of N2africa in Kano State, Nigeria”**. Please, you are requested to respond accordingly as the information would be use confidentially for academic purpose. Thanks.

MUHAMMAD HALLIRU
SPS/12/MEX/00006

Section A: Socioeconomic Characteristics of Farmers

1. L.G.A……………………Village…………………Questionnaire ID…………………….
2. Type of Village: a. Project site { } b. Control site { }
3. Name (Respondent)……………………………. Mobile No……………………………....
4. Crops: Legume:1)…………….2)……………..3)………….....Cereal:4)…………………
5. Sex a. Male { } b. Female { }
6. Marital status a. Single { } b. Married { } c. Divorced { } d. Widow { }
7. Household size……………………………………………………………………..
8. Household composition related to farm-plots defined in labour, consumption e.t.c

Respondent (start with household head)	Male=1 Female=2	Age (yrs)	**Occupation** 1=farming 2=civil service 3=livestock rearing 4=trading 5=others(specify)	**Farmingex perience** (yrs)	**Education level** 1=no formal education 2=primary education 3=secondary education 4=tertiary education	**Labour participation** 1=full time farmer 2=part-time farmer 3=not a farmer 4=others(specify)
Household head						

9. Household total land(ha)

Asset name	**Number of hectares**
Total cultivable land area	
Total cultivated area	
Total area fallow	
Area planted with soybean	
Area planted with cowpea	
Area planted with groundnut	
Area planted with cereals	

10. Give detail routine of plots separately in the Table below(year 2014):

Plot variables	**Plot/values**			
	Plot 1	**Plot 2**	**Plot 3**	**Plot 4**
Size (ha)				
Irrigated/rain fed				
Ownership				
Cultivated last 3 years(yes/no)				
Soil type				

Distance home walking (hrs)				
Main decision maker				
2014 rainy season cultivated (yes, fallow, leased out, grazing)				
Crop type 1				
Variety crop type 1				
Source seed crop type 1 variety 1(refer to code A)				
Inter-strip cropped crop type 1, variety 1				
Land size crop type 1, variety 1 (ha)				
Planting date crop type 1, variety 1				
Number of bags harvested (50kg) crop type 1, variety 1				
Inputs used crop type 1, variety 1				
Fertilizer inorganic				
Type 1 of fertilizer inorganic				
Amount used inorganic fertilizer type 1 crop type 1, variety 1 (kg)				
Source fertilizer type 1, crop type 1, variety 1				
Type 2 of fertilizer inorganic				
Amount used inorganic fertilizer type 2 crop type 1, variety 1 (kg)				
Source fertilizer type 2, crop type 1, variety 1**(refer to code A)**				
Herbicide used crop type 1, variety 1				
Manure used				
Bags expected to harvest crop type 1 variety 1				
Reasons for less bags harvested versus expected *				
Inputs-seeds wanted to apply-use but did not for crop type 1, var. 1				
Crop type 2				
Variety crop type 2				
Source seed crop type 2, variety 1**(refer to code A)**				
Land size crop type 2 (ha), variety 1				
Planting date crop type 2, variety 1				
Number of bags harvested (50kg) crop type , variety 1				
Inputs used crop type 2, variety 1				
Fertilizer inorganic				
Type 1 of fertilizer inorganic				
Amount used inorganic fertilizer type 1 crop type 2, variety 1 (kg)				
Source fertilizer type 1, crop type 2, variety 1				
Type 2 of fertilizer inorganic				
Amount used inorganic fertilizer type 2 crop type 2, variety 1 (kg)				
Source fertilizer type 2, crop type 2, variety 1**(refer to code A)**				
Herbicide used crop type 2, variety 1				
Manure used				
Bags expected to harvest crop type 2 variety 1				
Reasons for less bags harvested versus expected*				
Inputs-seeds wanted to apply-use but did not for crop type 2, var. 1				

11. Did legume production increase in the last 2 – 3 years? a.Yes { } b. No { }
12. Average annual income (in Naira)…………………………………………………
13. Membership of cooperative society a. Member { } b. Non-member { }
14. If non-member, state reason(s)………………………………………………………
15. If member, state name of the cooperative group……………………………………

16. Are those cooperatives functioning? a Yes { } b. No { }
17. If yes, state the functions………………………………………………………………
18. Agricultural information source a. Extension agent{} b. Media{} c. fellow farmers{}
19. Do you have contact to extension agent? Yes { } No { }
20. If yes, what is the frequency of your contact to extension agents?
    Daily { } b. weekly { } c. Fortnightly { } d. Monthly { } d. others { }
21. Usefulness of contact: a. very useful { } b. useful { } c. not useful { } d. can't tell { }

Section B: Input Demand among Smallholder Farmers

22. Awareness about input suppliers/dealers Aware { } Not aware { }
23. Are those input dealers available in your area Available { } Not available { }
24. Do you purchase inputs in your production? Yes { } No { }
25. State the input source, weather quantity meet demand and gap (if quantity not satisfied)

Inputs	**Source (code A)**	**Meet qty demand (1=Yes, 2=No)**	**if no (Input gap in kg)**
Inoculants			
Seeds			
Fertilizers			
Insecticides			
Pesticides			

Code A: 1=Research institutes 2=ADPs 3=open markets 4=Input companies 5=Agro dealers 6=Others (specify)

26. What is the distance to the input source (km)……………………………………
27. Do you regularly have information on input prices a. Yes { } b. No { }
28. if yes indicate sources of your market information a. market visit { } b. media (TV/Radi) { } c. other farmers { } d. middlemen { } e. extension agents { } f. others { }
29. Willingness to order inputs through farmers group

s/n	**Likeness to buy**	**Certified inputs component**				
		Inoculants	Improved Seeds	Fertilizers	Pesticides	Insecticides
1.	Very likely					
2.	Likely					
3.	May be					
4.	Unlikely					
5.	Very unlikely					
6.	Don't know					

30. What is your opinion/hope on market price of inputs?
    a. good market price { } b. not so good { } c. low market price { }

Section C: Awareness and Rate of Adoption of N_2 African Technology among Farmers

31. Which of these technologies have you adopted on N_2 Africa phase 1 Activities?

		Are you aware of this	**Do you try it**	**Do you adopt it**	**If yes indicate the year of**

S/N	Recommended Technology	technology						first adoption
		Yes	No	Yes	No	Yes	No	
1	Soybean variety							
2	Soybean Phosphorus Fertilizer and inoculant trial							
3	Cowpea variety and phosphorus trial							
4	G/nut variety trial							
5	G/nut variety and phosphorus fertilizer trial							
6	G/nut cropping system trial							
7	Cowpea variety							
8	Cowpea cereal strip/relay cropping trial							
9	Inter-row spacing							
10	Intra-row spacing							
11	Agro-chemicals application							

Section D: Input Utilization of Legume-cereal Production

32. What are the resources used in legume-cereal production?

Input	2013			2014			2015	Source (code A)
	Qty used in kg	Cost/unit (₦/kg)	Total cost(₦)	Qty used in kg	Cost/unit (₦/kg)	Total cost(₦)	Quantity Required(kg)	
Inoculants								
Fertilizers								
S.S.P								
N.PK								
UREA								
Manure								
Compost								
FYM								
Seeds								
Cowpea								
Soybean								
Groundnut								
Cereal								
Chemicals								
Insecticide								
Herbicides								

Code A: 1=Research institutes 2=ADPs 3=open markets 4=Input companies 5=Agro dealers 6=Others (specify)

33. Which kind of labour is used on the farm?

a) Family { } b. Hired { } c. Family and hired { }

34. Complete the Table regarding labour used in legume-cereal production (plot size):

	Paid labour					**Family labour**		
S/n	Operation	No. of labourers	No. of hours/day	No. of days spent	Unit cost (₦)	No. of labourers	No. of hrs spent/day	No. of days spent
1.	Land preparation							
	Adult male							
	Adult female							
	Children							
2.	Planting							

	Adult male							
	Adult female							
	Children							
3.	Fertappl (1st&2nd)							
	Adult male							
	Adult female							
	Children							
4.	Weedng (1st&2nd)							
	Adult male							
	Adult female							
	Children							
5.	Harvesting							
	Adult male							
	Adult female							
	Children							

35. Do you own farm implements a. Yes { } b. No { }

36. If yes, provide the following information:

S/n	Type	Qty	Unit cost (₦)	Years of purchase	life span	Total cost(₦)
1.	Hoe					
2.	Cutlass					
3.	Sprayer					
4.	Others					

37. Did you borrow/hired any type of agricultural equipment this year? Yes { } No { }

38. If yes, specify the equipment below:

s/n	Type	Source	Purpose	Condition of working	Rate (₦/ha)
1.					
2.					
3.					

Condition: 1= Good, 2=Fair, 3=Poor

Source: 1=ADP, 2=Ministry, 3=LGA, 4=Private, 5=Others

39. Provide information on Legume-cereal harvested during the 2 years by Household.

Crops	Variety	2013			2014		
		Area (ha)	Production		Area (ha)	Production	
			Quantity	Unit (Code A)		Quantity	Unit (Code A)
Cowpea							
Soybean							
G/nut							
Cereal							

Code A: 1= kg, 2= Kwano, 3= 50kg Bag, 4= 100kg Bag, 5= Ton, 6= Other Unit (Specify)

40. Provide the following information on legume-cereal harvest (all plots) for this year:

Crops	Variety	Total output (kg)		Qty sold (kg)		Unit price (₦)		Total (₦)		Qty saved as seed (kg)		Qty stored (kg)		Cosmpn Qty(kg)		Gift Qty (kg)	
		13	14	13	14	13	14	13	14	13	14	13	14	13	14	13	14

Cowpea																	
Soybean																	
G/nut																	
Cereal																	

41. Where do you usually sell the crops?
    a. Farm gate {} b. village market {} c. urban market d. others (specify)…………………
42. Who are your buyers?
    a. Rural assemblers {} b. rural wholesalers {} c. urban wholesalers {} d. others…............
43. Is there any difference in your output as a result of adoption of N2Africa technology?
    a. Yes { } b. No { }
44. If yes, how? a. increase { } b. decrease { }
45. If increase, how did the increased legume output affect your income/standard of living?
    a. Very high { } b. High { } c. Average { } d. Low { } e. Very low { }
46. Can you please rate your level of satisfaction with respect to the following aspects of legume production in the Table below?

s/n	Aspect of Legume cultivation	Responses (code A)		
		Cowpea	**Soybean**	**Groundnut**
1	Availability of inputs such as seeds etc.			
2	Price of Inputs			
3	Yield per Hectare			
4	Cost of transport from farm to market			
5	Price per unit of grain legumes(kg)			
6	Overall legume production			

Code A: 1= highly satisfied, 2= satisfied, 3= fairly satisfied, 4= not satisfied

Section Ea: Input Demand/Supply Constraints

47. Identify the major problems affecting input demand/supply

a. Input sourcing……………………………………………………………………..
b. Input quality……………………………………………………………………….
c. Input prices……………………………………………………………………..
d. Timeliness……………………………………………………………………………
e. Others (specify) ……………………………………………………………………..

Section Eb: Legume-cereal Production Constraints

48. Identify the major problems affecting adoption legume-cereal production system

a. Climate change…………………………………………………………………..
b. Production techniques…………………………………………………………….
c. Pest and diseases…………………………………………………………………….
d. Drought risk………………………………………………………………………….
e. Land ownership problem…………………………………………………………
f. Others (specify) ……………………………………………………………………….