SEED SYSTEMS AND MARKET FOR QUALITY DECLARED SEEDS OF OPV MAIZE AND BEAN IN KONGWA AND SIHA DISTRICTS

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ABSTRACT

Maize and beans are among the major staple food crops in Tanzania. However, among other things, production of both crops has been limited by low use of quality seeds. As part of its efforts, the government of Tanzania adopted Quality Declared Seeds (QDS) production system in 2000 to promote quality seeds use. The general objective of the study was to generate evidences that may contribute towards production and distribution of Quality Declared Maize and beans Seeds in Kongwa and Siha Districts respectively. Specifically, the study determined shares of seeds from different sources using descriptive analysis; identified factors influencing QDS purchase decision using binary logit regression and estimated household QDS demand using Cobb Douglass utility model. It involved sample of 120 randomly selected producers of each crop. Questionnaire, focus group discussion and key informant interview were used to collect data from farmers, QDS producers, input suppliers, TOSCI, ASA and DALDO offices. The study has revealed that maize production constituted of seeds obtained from own-saving (70%), QDS (15%), subsidized seeds (9%), other farmers (6%), input suppliers (0.1%) and seed kit programmes (0.1%). Beans production constituted seed obtained from own-saving (52%), market centers (36%), other farmers (10%) and nearby shops (3%). Furthermore, membership associations; access to subsidized seeds; demand for more varieties and higher income from agriculture increased the probability of farmers to purchase QDS while high use of own-saved seeds and seed exchange between farmers diminished purchase of QDS. Furthermore, the study has revealed that QDS demand was higher for HH with higher seed expenditure; previous use of QDS and access to market with higher prices of produce. This study recommends improving local seed systems; building capacity of farmers to purchase QDS, review of QDS legal market; improving agricultural market information system and improving preferred local varieties for QDS production.

DECLARATION

I, Owen Nelson Mghweno, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

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"Glory to the Almighty GOD, the one who strengthens me"

DEDICATION

I dedicate this dissertation manuscript to my father Mr. Nelson Mkwavi Mghweno and my mother Hannael Nelson for their diligent care with affection, love and dedicated parentship for the success of my life. I thank and love them so much, may GOD grant them health and long life. Amen.

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LIST OF ABBREVIATIONS

AGRA	Alliance for a Green Revolution in Africa
ASA	Agricultural Seed Agency
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
B/C CRSP	Bean/Cowpea Collaborative Research Support Programme
BACAS	Bureau of Agricultural Consultancy and Advisory Services
CABI	Commonwealth Agricultural Bureau International
CALR	Centre for Agriculture and Livestock Research
CBSPS	Community Based Seed Production Scheme
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
COSTECH	Commission of Science and Technology
DALDO	District Agricultural and Livestock Development Officer
ECAPAPA	Eastern and Central Africa Programme for Agricultural Policy Analysis
FAO	Food and Agriculture Organization of the United Nations
FEWS	Famine Early Warning System
ICARDA	International Center for Agricultural Research in the Dry Areas
ICAR	India Council of Agricultural Research
ICRISAT	International Crops Research Institute for the Semi Arid Tropics
IFLA	International Federation of Library Associations and Institutions
IFPRI	International Food Policy Research Institute
KDC	Kongwa District Council
LVIA	Lay Volunteers International Agency

MAFC	Ministry of Agriculture, Food security and Cooperative
MAFS	Ministry of Agriculture and Food security
NAIVS	National Input Voucher System
NGO	Non Governmental Organization
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Square
OPV	Open Pollinated Varieties
PEA	Partial equilibrium analysis
QDS	Quality Declared Seeds
SADC	Southern Africa Development Cooperation
SARI	Selian Agricultural Research Institute
SDC	Siha District Council
SNAL	Sokoine National Agriculture Library
SUA	Sokoine University of Agriculture
TANSEED	Tanzania Seed Company
TOSCI	Tanzania Official Seed Certification Institute
URT	United Republic of Tanzania
WANA	West Asia and North Africa
WRS	Warehouse Receipt System

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Agriculture is the largest sector and a dominant driving force for the development and growth of Tanzanian economy. According to MAFC (2009), agriculture contributes about 26.5 percent of GDP and 30 per cent of export earnings and provides employment to about 75% of the total labour force. Tanzania national agricultural census of 2007/08 report shows that most of the agricultural land (85%) has been planted with annual crops implying regular demand for seeds and other planting materials mainly for maize and beans which are among the most grown and consumed crops in Tanzania (MAFC, 2012). Unlike fertilizer and pesticides, farmers cannot be in production without seed. It has been documented in most of the literature that among inputs required for crop production seeds and other planting materials form the basis of crop production (Broek *et al.*, 2009).

Quality of seeds used for producing a crop determines productivity of other factors of production such as land and labour. However, the limited numbers of private seed enterprises and the low attention accorded to the informal seed sector narrowed the options available to farmers for obtaining improved varieties at affordable prices at the right place and time (Asfaw *et al.*, 2008). As one of the strategies to promote use of quality seeds among small scale farmers Tanzania modified and adopted by Quality Declared Seed (QDS) scheme in 2001 and incorporated it in its seed act of 2003 (Granqvst, 2009). QDS system was developed by FAO in 1981 as a seed certification scheme to compliment stringent and costly mandatory certification system and it was identified as a strategy to increase the availability of quality seed for the agricultural communities (FAO, 2006). QDS can be produced by a registered trained small scale farmer or a group of small-scale farmers for their own use or for sale to the neighbouring farmers within the ward (MAFC, 2001). According to ICARDA (2009) and Granqvst (2009) most of districts in Tanzania have included QDS production in their agricultural programmes.

1.2 Problem Statement and Justification

High production of maize and beans as among major staple food crops in Tanzania reflect high demand for seeds for producing both crops. However, the demand for quality seeds from formal seed suppliers for producing both crops is low (Katungi *et al*., 2011). Private seed companies avoid marketing OPV maize and self-pollinated crop seeds like beans due to competition from farm-saved seeds (Nkonya and Kato, 2001). As a result farmers continue to recycle such seeds over a long period of time and occasionally demand new seed from outside to replace their seed (Olatokun *et al.,* 2010). Despite all the necessary elements of the formal seed system that are in place, improved seed supply and demand are low (Mizambwa, 2012). Planted area with quality seeds accounts for the smallest part of total cultivated land (17%) while the largest part of the cultivated area (83%) still uses the seeds of poor quality (URT, 2012).

Rural seed markets have wide range of seed qualities from highly improved seed (made through intensive breeding) to highly degraded seed (from inbred material or material that have lost the good genes (Graudal and Lilleso, 2007). Since the adoption of quality declared seed (QDS) scheme in Tanzania in early 2000s to fill the gap between quality seed supply and demand in rural areas, QDS accounts for relatively very small amounts of seeds in Tanzania (URT, 2012; AGRA, 2010; Mtenga (2001). According to MAFC seed status report for the year 2012, QDS constituted only 0.65% of quality maize seed sales and for the case of bean QDS constituted only 6.9% of seed sales (MAFC, 2012).

Agricultural Sector Program Support (ASPS) has been promoting Quality Declared Seed (QDS) production but its contribution to reverse low use of quality seeds is low (Hillocks, 2006). Despite of farmers interest in improved, commercial varieties and efforts to establish QDS in rural areas (Phiri, 2006) it has been documented that there is still low understanding of demand for seeds from off-farm sources (Minot *et al.*, 2007; Kugbei and Shahab, 2007; MAFC, 2012). Researchers have not been accustomed to consider about how farmers procure seed, their seed requirements and what community-based networks exist to provide for farmers needs (Nicholaus *et al.*, 2000). Furthermore Lyimo (2006) documented inadequately research response to farmers demands for quality seeds. It has been recommended the need for further study on the market for QDS and the effects of the local seed system on marketing of QDS (BACAS, 2007; Granqvst, 2009).

1.3 Research Objectives

1.3.1 General objective

The general objective of the study was to generate evidences that may contribute towards production and distribution of Quality Declared Maize and beans Seeds in Kongwa and Siha Districts respectively.

1.3.2 Specific objectives

Specifically this study;

i) Determined proportion of seeds used by farmers from different sources.

ii) Identified key factors which influence purchase decision of Quality Declared Seeds.

iii) Estimated the demand of maize and bean Quality Declared Seeds.

1.4 Research Questions

This study answers the following study questions;

i) What are the proportions of seeds used by farmers from different sources?

ii) Which are the key factors influencing purchasing decision of Quality Declared Seeds?

iii) What is the demand for maize and bean QDS?

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical Framework

Among the most important thing in studying the market for a particular product is to understand the behaviour of its consumers. Economic theory suggests that consumer behaviour for a particular product can be understood through analysing demand for that product. Since developing countries farmers have acted differently to use of seeds from different sources and or of different crops and varieties (Minot *et al.*, 2007), this study use demand theory approach to describe seed consumer (farmers) behaviours as a target market for producers of quality declared seeds (QDS) in the study areas. Demand for seeds as input (factor) for crop production can be analysed as demand for other commodities (Varian, 1992).

The demand for preferred seeds within the community is assessed, so that quantities to be produced can be estimated, to prevent under- or over-supply of seed (Sentimela and Kosina, 2006). Generally the objective of analysing demand is to explain the level of demand for the commodities an individual consumes given the structure of relative prices faced, income, and a set of individual characteristics such as age, education, professional status, type of household to which he belongs, and geographical environment and this form the basis of an econometric analysis of demand (Sadoulet and De Janvry, 1995; Woodridge, 1999).

Data used in this study were cross sectional data from household survey. According to Nadiri and Prucha (2001) demand analysis with cross sectional data induce static demand model. Few studies, however, incorporate the use of cross-sectional data to examine the effects of differences in price, lifestyles, tastes, and preferences on demand (Yen and Huang, 2004). Demand analysis using time series data have been mostly preferred to cross sectional data because time series data can be used to establish a dynamic demand model and generates a rich set of critical information for forecasting future demand (Nadiri and Prucha, 2001).

Since household surveys typically collect data on clusters of households that live together in the same area and are surveyed at the same time, there is no genuine variation in market prices within each cluster for forecasting future demand (Gibson *et al.*, 2004). However demand studies based on cross sectional data provide better insights on how different groups within the population behave (Yen and Huang, 2004). Prices in cross-sectional data are generally assumed to reflect quality effects which are caused by variation in cross-sectional prices arising from the opportunity costs of time and price benefits of information search (Cox and Wohlgenant, 1989).

One of the major advances in the literature works related to demand analysis has been the formulation of flexible functional forms such as Cobb-Douglas demand functions (Nadir and Prucha, 2001). From the Cobb Douglass equation, flexible functional and transcendental logarithmic have been introduced. These functional forms do not impose a priori restrictive constraint such as homotheticity, constancy of elasticity of substitution and additivity. According to Bingxin Yu *et al.* (2010); Sadoulet and De Janvry (1995); Madnan (1990) and Weigner and Baltazzis, 1973) transformation of Cobb Douglass utility function to translog demand system provide equation that can be used for demand analysis using Ordinary Least Square (OLS) regression. It has been recommended that OLS regression analysis offers good analytical tool for demand analysis (Sentimela and Kosina, 2006).

Sadoulet and De Janvry (1995) specifies one of mostly used translog demand system in a pragmatic fashion without recourse to economic theory. A typical situation, for instance, is to estimate from time series data the income and price elasticities for a commodity *i* in a constant elasticity demand equation such as:

$$\ln q_i = \alpha + \sum_j E_{ij} \ln \frac{P_j}{P} + n_i \ln \frac{y}{P} + \sum_k b_{ik} \ln z_k + U \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where: q_i is quantity purchased of good, p_i, p_j = prices of good i and of selected other commodities j which are close substitutes or complements, y = total expenditure per capita, P = consumer price index, E_{ij} = direct and cross-price elasticities, n_i= expenditure elasticity, z_k = household characteristics, time (to account for steady changes in tastes, in the distribution of income, and in the quality of products), and other exogenous variables, and b_{ik} = elasticities of demand with respect to z_k.

However equation 1 is based on time series data for demand analysis. However, other literature such as Wold and Jureen (1953); Cox and Wohlgenant (1989); Yen and Huang, (2004) and Bingxin Yu *et al* (2010) suggests similar multiple linear regression approach which is suitable for cross sectional demand analysis (Equation 2).

$$\ln q = \alpha + e_{ii} \ln P + e_{ij} \ln P_{ij} + e_m \ln M + xX \ldots + yY + Z \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where Z is disturbance, deterministic component are such as M is income, e_m is income elasticity, P is commodity price, e_{ii} is own price elasticity, e_{ij} is cross price elasticity. To determine parameter α, e_{ii}, e_{ij} , e_m, x...... and y, OLS regression make the residual sum of square a minimum. For the case when X, Y... are not quantitative data may be classified according to the number.

From equation 2 we can find some important economic parameters to explain the nature of demand for QDS seeds which are own price elasticity (e_{ii}) to refer to elasticity with respect to the price of commodity i, cross price elasticity (e_{ij}) to refer to quantity elasticity with respect to the price of commodity j and is income elasticity (e_m) to refers to elasticity of quantity demanded with respect to total expenditure. Furthermore equation 2 provides room for including respondent characteristics as dummy variables which influence demand for a commodity.

This pragmatic approach is attractive in its simplicity and is practicable using OLS regression, but has some drawbacks. The choice of functional forms for the demand equations and of the variables to be included is arbitrary. The guidelines used are usually a combination of common sense, interest in specific elasticities, computational convenience, and goodness of fit criteria. The functional form used above postulates constancy of the elasticities over all values of the exogenous variables. A third drawback is that the set of demand equations estimated in this fashion leads to predictions which do not satisfy the budget constraint that limits total expenditure.

An alternative approach to the estimation of demand equation parameters uses the theory of demand as a guideline for the choice of functional forms and variables to be included. In particular, the theory allows the derivation of estimable functional forms of demand equations from mathematically specified models of consumer choice and the imposition of constraints on demand parameters to reduce the number of independent parameters to be estimated to manageable numbers relative to the data available (Sodoulet and De Janvry, 1995). So despite some drawbacks of the pragmatic single equation for analysis it is practicable, and have been used in many studies including Sturmey and

Pearce (1966), Madnan (1990), Varian (1992), Bapna and Rao (1994), Sadoulet and De Janvry, (1995), Bingxin Yu *et al.* (2010).

2.2 Development of Seed Industry in Tanzania

Due to the importance of seeds several strategies have been employed by farmers, government, private and international organization to ensure that quality seeds are timely accessible. From such strategies and actors, the set of interconnected institutions have been in place for developing new varieties and producing, testing, certifying, and marketing seed to make sure seeds are available for crop productions. Such interconnections of actors and activities form seed industry, seed sector or seed system. Although some of such functions, such as certification, are not performed by the informal sector, the informal sector is part of the seed system. The seed industry development focuses on establishing a formal sealed system (Mtenga *et al.*, 2001). Development of seed sector involves breeding to improve crop varieties, seed multiplication, processing, certification and strengthening distribution networks (Mizambwa, 2011).

The development of the seed industry in Tanzania started in 1960s. After adoption of socialistic policies following independence in 1961 till 1990s the government of Tanzania had been responsible for the national seed production and distribution. Tanzania Seed Company Limited (TANSEED), a government parastatal was established in 1973 to produce sufficient certified seed for farmers at affordable prices, and for providing seed extension, dissemination, and advisory services. TANSEED had an ultimate role in seed production, importation, distribution, and sale of certified seeds.

As a monopoly firm TANSEED failed to perform its duties efficiently and effectively which resulted in poor performance of the national seed industry. Several problems contributed to poor performance and low impact of improved seeds that were handled by TANSEED, including insufficient transport and funding, lack of humidity-controlled warehouses and inadequate seed drying equipment (Mtenga *et al.*, 2001). Due to the deficiencies of TANSEED and in recognition of the existence of a relatively large untapped market for improved seed in Tanzania, the government liberalized the seed industry. In 1989, the Tanzanian government liberalized the seed market, exposing TANSEED to competition from private seed companies (Minot *et al.*, 2007). After liberalization, a number of foreign and domestic private seed companies entered the seed sector to produce, distribute, and market improved seed (Mtenga *et al.*, 2001).

Despite Tanzania shift away from reliance on public seed enterprises and more interest towards private smallholder seed production low supply and low use of quality seeds still prevail as among major constraint to crop production in the country (URT, 2012). Poor seed limits the potential yield and reduces the productivity of the farmers labour however there are several systems commonly relied for supplying farmer with seeds with a wider range of qualities. Seed production and supply systems have been commonly classified into two systems which are informal and formal seed delivery system (Phiri, 2006). However, most of literatures suggest three types of seed systems in Africa as; informal seed system (traditional or local seed supply system), integrated seed (semi formal or community based) systems and the formal (commercial) seed supply systems.

a) Informal seed system

The informal seed sector where farmer-saved and farmer-traded seed have been the major source of seed in Tanzania (Minot, 2008). Informal seed systems focus on farmer management of local varieties which have been selected overtime and produced under local circumstance. An informal, traditional or farmer seed system lacks public sector regulation (Bentley *et al.*, 2011).

Informal seed sector operates mainly at local level through exchange mechanisms involving limited quantities per transaction. Farmers consider their own seed (farmer-saved) or that of their social network (farmer-traded) to be readily available, affordable and trusted (Phiri, 2006). It provides about 80-100% of the seeds used by farmers in Africa (Wekundah, 2012) and in Tanzania it provides about 90% of seeds (URT, 2012).

b) Formal seed supply systems

Formal systems are purposefully composed of separate activities to provide new varieties, maintain their purity, certify the seeds and distribute them to farmers, usually through officially recognized seed outlets (Bentley *et al.*, 2011). The systems cover seed production and supply mechanisms that are ruled by defined methodologies. The system has uniform standards based on distinctness, uniformity and stability (DUS).

Formal seed sector supply certified seeds and is comprised of public sector which consists of ministry and parastatal enterprises, private sector which includes profit oriented seed dealers and voluntary organizations (Cromwel, 1996). In Tanzania the system supplies only 10-20% of seed requirement (Wekundah, 2012).

Despite of liberalization of the seed sector in Tanzania from single monopoly public seed company, most of private seed companies concentrate on maize seeds only neglecting other crops such as beans (MAFC, 2012). Government interventions in formal system are in seed quality control and promoting the use of quality seeds and National Input Voucher

System (NAIVS) has become an important policy instrument for promoting the use of quality inputs including seeds in Tanzania (Minot, 2009).

c) Integrated seed system

The formal seed system, with the exception of truth-in-labeling, requires mandatory varietal and seed certification where seed production fields are inspected and seed lots are tested for quality for commercialization of certified seed. Such mandatory system requires huge physical, financial and human resources, which is far beyond the reach of many developing country certification programs (ICARDA, 2009). The integrated seed system covers methodologies that aim to improve local seed supply systems, borrowing technologies and improvements from the formal sector and using informal channels. The systems make use of both locally improved seeds and formally improved varieties produced through formal system.

The most famous integrated seed supply system is Quality Declared Seeds (QDS) system developed in 1981 as an alternative seed certification scheme to compliment stringent and costly mandatory certification system, QDS was identified as a strategy to increase the availability of quality seed for the agricultural community (FAO, 2006; Granqvst, 2009). In 2001, the Government of Tanzania modified and adopted the QDS system and incorporated it into the national Seeds Act of 2003 and its seed rules, regulations, procedures and guidelines of 2007 (URT, 2003; URT, 2007).

Up to 2007 more than 90 % of the districts in Tanzania decided to support and include QDS production in their respective areas and in other district some extension officers have also been trained as authorized district seed inspectors (ICARDA, 2009; Granqvst, 2009). The system has also been providing an opportunity for small scale seed enterprises for contract certified seed production using formalized standards and integrating them into the market through large suppliers (Wekundah, 2012).

Table 1: Differences between formal and informal seed systems

Components	Formal sector	Informal sector
Varietal development	Plant breeders employed by the government or private firms select for specific traits and produce varietally pure "breeder seed".	Farmers select seed from plants with desirable traits, but the seed is not necessarily varietally pure.
Seed production	State or private seed companies multiply seed under strict conditions to avoid mixture of varieties, sometimes using contract farmers.	Farmers produce seed along with crops; in some cases the portion of the crop destined for seed is given special management.
Processing	Seed is dried using mechanical dryers. Seed processing machinery used to remove dirt, rocks, and seeds of other plants. May be treated to extend shelf life.	Seed may be cleaned by hand, dried in the sun, and sometimes treated to extend shelf-life.
Certification	Seed is usually subjected to some formal quality control procedure based on tests of purity and germination of random samples.	Seed is generally not tested, certified, or labelled.
Distribution	Seed is bagged and labelled and distributed by stockists, extension agents, NGOs, and cooperatives.	Farmers use seed they save from previous harvest; acquire from other farmers through barter, gift, or sales; or acquire in local grain markets.

Source: Minot *et al.* (2007)

2.2.1 Seed quality and security

An understanding of the technical and operational aspects of seed quality is essential in studying seed industry. FAO (2010) defined seed quality based on four basic parameters which are; Physical qualities of the seed in the specific seed lot; Physiological qualities which refers to aspects of performance of the seed; Genetic quality which relates to specific genetic characteristics of seed variety and Seed health which refers to the presence of diseases and pests within a seed lot. High-quality seed is a pre-requisite to achieve maximum outputs and good returns for farmers therefore seed intended for domestic or international markets should be controlled and inspected by official sources in order to guarantee consistent high quality for consumers (OECD, 2012).

Tanzania has a strong legal regime that regulates seed variety release, seed certification, and quarantine and phytosanitary measures. Seed quality control is done by the Tanzania Seed Certification Institute (TOSCI) (URT, 2003). The laws include the Seeds Act of 2003 accompanied by the Seeds Regulations of 2007 and the Plant Protection Act of 1997 accompanied by the Plant Protection Regulations of 1998. These laws are administered by the Ministry of Agriculture, Food Security and Cooperatives (CALR, 2012). Considerable progress has been made in the harmonization of seed policies and the seed certification procedures have been standardized to the OECD standards while most laboratory testing is based on International Seed Testing Association (ISTA) rules. The OECD Seed Schemes provide an international framework for the certification of seed aiming to facilitate seed trade by reducing technical barriers, improving transparency and lowering transaction costs. Even though Tanzania has been following OECD standards it has not yet registered to OECD (Waithaka *et al.*, 2011). The OECD Seed Schemes were set up in 1958 with the objective of encouraging the use of seed of consistently high quality in participating countries (OECD, 2012). In 2008 SADC came up with seed certification system with five seed certification classes which incorporate QDS (Table 2), however, the SADC system does not imply that seed produced under other quality assurance systems cannot be traded in or between SADC countries.

Table 2: SADC seed certification and Quality assurance system: Seed classes

Seed Class	Code	Produced from	Label colours
Pre-basic Seed	A	Breeder's Seed	Violet band on white
Basic Seed	B	Pre-Basic or Breeder's Seed	White
Certified Seed (1st Generation)	C1	Basic or higher seed classes	Blue
Certified Seed (2nd Generation)	C2	C1 or higher classes of seed	Red
Quality Declared Seed	QDS	Complies with special requirements	Green

Source: SADC (2008).

Another important aspect of the seed industry is to ensure seed security, where as seed security has been defined as "access by farming households (men and women) to adequate quantities of good quality seed and planting materials of adapted crop varieties at all times both good and bad (FAO, 2010). Seed insecurity is among challenge facing farmers in SSA countries (Minot *et al.,* 2007). Seed security can be explained based on three parameters; availability, access and suitability (Table 3).

Table 3: Features of seed security

Parameter	Seed security
Availability	Sufficient quantity of seed of adapted crops are within reasonable proximity (spatial availability), and in time for critical sowing periods (temporal availability).
Access	People have adequate income or other resources to purchase or barter for appropriate seeds.
Suitability	Seed is of acceptable quality and of desired varieties (seed health, physiological quality, and variety integrity).

Source: FAO (2010)

Analyses that were undertaken using the seed security framework have revealed that, seed is often available but farmers do not have the resources to buy it, i.e. there is a lack of access to seed (FAO, 2010). The Quality Declared Seed (QDS) scheme, developed by FAO, provides seed quality standards that are used as minimum standards for quality seed to be available at lower price for purchase by small scale farmers in their locality

(Granqvst, 2009). For that reason QDS has elements of both seed quality and security for small scale farmers in rural areas where formal seed system has failed to provide seed security. Therefore while there is the insecurity of quality seeds through formal system, in an informal system farmers use recycled seeds in strive to be seed secured but the establishment of QDS offers both seed quality and security for small scale farmers.

2.2.2 Origin of quality declared seeds

In 1980s; FAO and its member countries have developed Quality Declared Seeds (QDS), a system of quality assurance which does not require stringent seed certification procedures. Seed multiplication is undertaken at the community level to build more sustainable seed security (FAO, 2010). Quality Declared Seed (QDS) system aims at assisting small-scale farmers as well as specialists in seed production, field agronomists and agricultural extension agents to initiate the production of quality seed at community level (FAO, 2006; OECD, 2012). The purpose of QDS is to have a realistic quality assurance process and standards for seeds in countries that are in the initial stages of seed industry development (FAO, 2010).

Tanzania Seed Act of 2003 defines Quality Declared Seed as seed produced by a registered smallholder farmer which conforms to the specified standards for crop species concerned and which has been subject to the quality control measures prescribed in the regulations to be made under the act. In Wakundah (2012) and MAFC (2002) QDS is referred as standard seeds and based on two common seed systems (formal and informal system), QDS is of higher quality, but still sold at lower and affordable prices and seed price is set by local market condition in the ward or the district and therefore builds demand and supply of seeds of better quality and varieties (ICARDA, 2009). QDS system does not replace a fully developed seed certification program, but proposes an alternative which requires fewer demands on government resources, and yet still provides good quality seed with limited resources for seed certification (FAO, 2006 and MAFC, 2001).

The QDS system is less demanding than certified seed quality assurance systems, but guarantees a satisfactory level of seed quality (OECD, 2012). In controlling QDS quality in Tanzania, TOSCI relies on inspection agents who have been trained by the Institution to monitor and inspect the bulk of the production process. According to MAFS (2002) the following criteria are checked for QDS during inspection; Access to seeds which is of eligible variety and suitable for further multiplication; Suitable area for seed production, non-contaminated area or areas close to similar crops; Basic knowledge in seed production technology including field inspection, quality control and conditioning; Access to suitable equipment and seed conditioning and storage and Access to a seed-testing laboratory. QDS has upgraded the quality of farm saved seed and the trust in QDS seed is higher than in other purchased seed (Danielsen *et al.*, 2006). Therefore, in using QDS system, there have been considerable advantages for managing seed quality control where market infrastructures and seed regulatory resources are constrained.

2.2.3 Development of QDS scheme in Tanzania

In 1990s Tanzania turned away from reliance on public seed enterprises and has since then directed more interest towards private smallholder seed production and since then QDS scheme was introduced in Tanzania (Granqvst, 2009). Community Based Seed Production Scheme (CBSPS) practiced earlier in Tanzania to increase farmers access to improved and preferred varieties in order to generate income, or to achieve better seed security formed basis for introducing QDS scheme (Mtenga *et al.*, 2001). CBSPS started with a few kilograms of a specific preferred variety, which a seed grower multiplies and makes available to other farmers in the community (Sentimela and Kosina, 2006).

In Tanzania community based seed scheme started to be implemented in 1990s through Bean/Cowpea Collaborative Research Support Programme (CRSP) between SUA, ARIS and NGOs which together formed a basis for beans and maize QDS establishment in some districts including Siha and Kongwa (Mtenga *et al.*, 2001 and Granqvst, 2009). These earlier smallholder seed production programmes in Tanzania intended to complement large-scale seed production by being part of a seed production system that integrates small and large-scale seed production systems (Mtenga *et al.*, 2001).

According to QDS production procedures and guides; QDS should be produced by a registered trained small scale farmer or a group of small-scale farmers producing seed for their own use or for sale to the neighbouring farmers within the ward where the QDS is produced (MAFC, 2001 and Granqvst, 2009). A farmer or group of farmer who wishes to become a QDS producer must submit an application to the national official certification agency (FAO 2006; ICARDA, 2009). QDS should be multiplied from basic or foundation seeds (B) to produce QDS grade 2 or from certified seeds grade 1 (C1) to produce QDS grade 2 (MAFC, 2001). Only OPV and self pollinated varieties can be produced through QDS scheme (MAFC, 2001). After registration and initial inspection of the field, an authorized district seed inspector inspects only 10% of all seed production fields (spot-check controls) sample the seed lots. After passing quality tests TOSCI approve seeds as QDS, and seeds become ready for sale to farmers. According to ICARDA (2009) more than 90% of districts in Tanzania have included QDS production in district agricultural programmes.

Through QDS programmes in Tanzania farmers choose varieties of their preferences and in some cases are introduced to new technologies when they use quality seeds. QDS has improved the smaller holder farmers access to improved seeds and it has been used as an alternative way to reach small-scale farmers who do not have access to certified seed for crop production (ICARDA 2009; MAFC, 2012). According to Granqvst, (2009) QDS has been addressing the key gap between formal sector certified seed supply and small-scale farmers demand for quality seed and access to new improved varieties. Despite different seed programmes the availability and demand for improved seed varieties to rural farmers is still very low and seed marketing per se is not strong in developing country like Tanzania (Minot, 2008). After review of literature, Table 4 summarizes key stakeholders and their roles in Quality Declared Seeds system in Tanzania.

Table 4: Key stakeholders of QDS system in Tanzania

Key stakeholders	Roles
Farmers	The target market for QDS.
Private seed companies	Supply certified seeds.
QDS producers	Produce quality declared seeds.
Input suppliers	Distribute quality seeds.
Consumers	Consumers/buyers of agro-produces.
TOSCI	Seed quality control
ASA	Promoting the use of quality seeds.
Local authorities	Supporting the establishment and sustainability of agricultural projects.
Research institutions e.g. SUA and ARI	Research and training.
Private institutions (NGO, Financial institutions, International organizations etc.)	Supporting QDS scheme initiative and sustainability.

2.3 Economic Characteristics of Tanzania Seed Sector

Experiences for seed development programs in SSA has outlined six relevant economical characteristics of seed and their implications for the organization of the seed system in SSA namely; easier to produce, use of recycled seeds, variation in quality, variation in demand, poverty among seed consumers and implication for the role of the government in seed systems (Minot *et al.,* 2007). With addition of support from other literature these six characteristics can be termed as important considerations in studying Tanzania rural seed market.

a) Seed is easy to produce

Seeds are easy to reproduce for OPV varieties and self-pollinating crops because they maintain their genetic characteristics over many generations (Minot *et al.*, 2007). Due to seed recycling smallholder farmers view seed as cheap and affordable to them, despite their low quality (CALR, 2012). This explains why farmers generally use purchased vegetable and hybrid maize seed, but for OPV maize and self pollinating crops such as wheat and beans they often use seed saved from their own harvests for years without purchasing new seed (Minot *et al.*, 2007; Nkonya and Kato, 2001; Katungi *et al.*, 2011; FAO, 2006).

According to Granqvst (2009) it is difficult for a private seed company to deal with OPV and self pollinating crops if farmers purchase the seed once and then recycle the seed for many years.). According to FAO (2006) QDS production is easier way to produce quality seeds for ensuring seed security to supplement shortage of certified seeds where formal seed sector have failed to secure quality seeds.

b) Quality is highly variable

Quality seed is critical to agricultural production since poor seed limits the potential yield and reduces the productivity of the farmers labour (Wakundah, 2011). From harvested produces farmers often choose varietal mixtures that may be more resistant to disease, pests, and abiotic stress leading them to use of mixture of genetic lines which mature at different times, and generally have a lower yield potential (Minot *et al.*, 2007). The supply of farmer-saved and farmer-traded seed is, however, prone to disruption as a result of natural and civil upheavals, drought, pests and diseases (both on-farm and in storage).

While the genetic traits of seed in the informal sector may be favourable for certain conditions or uses, it does not necessarily benefit from the higher yield potential, pest/disease resistance or tolerance to a range of physical conditions, available in improved, commercial varieties i.e. the formal seed sector (Phiri, 2006). Dissemination of QDS scheme offers quality seeds which are produced within the locality to ensure sustainable availability of seeds which are more adapted to specific climatic condition (ICARDA, 2009; FAO, 2006).

c) Quality is unobservable

When buying seed, the farmer can only inspect for physical impurities but it is not possible to know the genetic potential or the germination rate until after planting therefore in the absence of other information, farmers may pay a premium for high-quality seed without being sure that the quality is actually higher (Minot *et al.,* 2007). In practice, farmers make use of other sources of information as they rely on their experience with the seed in previous years, they may infer seed quality from the packaging and physical purity, they may decide based on the reputation of the vendor or the seed producer, or they may ask other farmers about their experiences with the seed. However, QDS are produced and supplied within farmers community so that it is easier for small scale farmers to observe seeds from production, supply and themselves are buyer thereby making easier for them to assess quality of seeds offered through QDS scheme (MAFC, 2001; FAO, 2006; Granqvst, 2009).

d) Seed demand is highly variable

According to Minot *et al.* (2007) the demand for seed exhibits strong intra-annual and inter-annual fluctuations and is highly seasonal varying from year to year as a function of weather, prices and the amount of seed saved from the previous year lead to competition which cause the demand for commercial seeds highly price elastic. However, MAFC (2012) data show a growth trend in sales in Metric Tonnes (MT) of maize and bean seeds of various grades (Table 5) from 2007/08 to 2011/12.

Table 5: Trend of certified and QDS seed sales in Tanzania

Crop	Seed class	2007/08	2008/09	2009/10	2010/11	2011/12
Maize	Certified (MT)	7 237	11 401	15 046	25 007	17 000
	QDS (MT)	20.9	22.3	79.5	114	111.8
Beans	Certified (MT)	62.2	118.8	213	110.6	223.8
	QDS (MT)	0	0	4	8.9	16.7

Source: URT, 2012.

MAFC (2012) report (Table 5) shows that use of both QDS and certified seeds for maize production is higher than in bean production. However, it has been documented in most of the literature that despite the growing trend in quality seeds use in Tanzania the supply is lower than actual demand for seeds. The demand for seeds is highly heterogeneous, due to the high variation in productivity and differences in the level of risks associated with crop failures (Takeshima and Sheu, 2009). According to Minot (2009) demand patterns vary significantly because of the differences in capacity of farmers to overcome various constraints.

e) Seed customers are poor

Most seed customers in Sub-Saharan Africa are poor and risk adverse (Takeshima and Sheu, 2009). According to Steiner (2012) such situation of the target market, private seed companies have little interest and prospect of successfully developing a market for highyielding varieties which depend on a minimum of production inputs and QDS is an appropriate system for ensuring seed security in rural areas.

Cash constraints prevent farmers from purchasing seeds and other inputs even when it is profitable to do so (Minot *et al.*, 2007). This may be one reason why farmers at risk-prone environment are less likely to rely entirely on the certified or varietal-pure seeds and more likely to use mixtures or combinations of varieties, including recycled seeds (Graudal and Lilleso, 2007). FAO (2006) and Granqvst (2009) documented that QDS scheme offers quality seeds for poor communities at a price which can be afforded by small scale farmers. Kugbei and Shahab (2007) recommend the assessment to determine whether farmers really use cash to buy seed and from which sources, how much money they spend to buy seed, their reasons for buying seed and the prices they pay to be critical aspects of seed demand analysis.

f) Role of government in seed systems

The fact that small-scale agriculture is the main source of income for the majority of the poor in most African countries suggests that there is a strong equity argument for public investments to improve agricultural productivity, including efforts to strengthen the system of developing new crop varieties and delivering them to farmers (Minot *et al.*, 2007). QDS must be produced by a registered and trained small-scale farmer or a group of small-scale farmers engaged in producing seed for sale to neighbouring farmers within the ward where the seed is produced. The national official certification institute (TOSCI) control QDS quality in collaboration with district seed inspectors, therefore localizing mandatory certification requirements for small scale farmers to produce and access quality seeds (MAFC, 2001).

2.3 Factors Affecting Demand for Quality Seeds

a) Competition from farmer saved seeds

The main and most powerful competitors for creating a sustainable demand for quality seed which may also affect QDS demand response from small scale farmers are; the traditional habit of recycling grain with its associated benefits (price and place convenience); the distribution of seeds free of cost or subsidized through governmental and aid programs (prize convenience) and the offer of hybrid seeds (product convenience) (Steiner, 2012). To avoid conflicts in the seed market it is recommended for QDS producers not to produce QDS for crops or varieties which are already successfully supplied through formal seed trade in that area (ICARDA, 2009). Kugbei and Shahab (2007) documented three main reasons which cause low seed demand from off farm sources which are either own saved seed was enough, the farmer had no money to buy seed or there was no seed available for sale.

b) Customers characteristics

In practice, farmers rely on their experience with the seed in previous years, they may infer seed quality from the packaging and physical purity, they may decide based on the reputation of the vendor or the seed producer, or they may ask other farmers about their experiences with the seed (Minot *et al.,* 2007). The experience in sub-Saharan Africa is that farmers do respond to incentives given an affordable technological package and an assured market for the output, farmers are quite responsive (Minot *et al.,* 2007). Most of the farmers are small-scale semi-subsistence who rely on retained seeds and informal exchange and some of such farmers group is seed-insecure who are forced to consume all or a major portion of their harvests because of severe chronic household economic conditions or temporary emergencies, drought, flood, war, disease/insect infestation (Howard *et al.*, 2000).

Temu *et al.* (2011) using a logit model determined factors affecting use of seeds of improved maize variety where age of respondent, marital status of household head, household decision maker, economic status of household, association membership and access to credit were found to affect adoption. It was found that married households were less likely to adopt improved maize varieties, getting married decreases the odds ratio (of adopting to non-adopting), moving from whole family based decision making to only household head decision making reduces odds ratio, when compared the medium wealth class farmers with those in the poor class, being in the later group decreases the odds ratio (of adopting to non-adopting) and if a farming household moves from medium wealth class to rich wealth class, then its odds ratio of adopting improved maize varieties increases.

c) Crops and varieties

The type of crop and variety influences how often farmers seek seed (Lanteri and Quagliotti, 1997). Seed of self-pollinated crops (e.g. Many grain legumes) are easily multiplied and more suited to dissemination through the informal seed system lead to farmers with low demand for seeds from off farm sources while cross-pollinated crops (e.g., maize, sorghum and millet) attract both formal, informal seed systems but crops that have a high multiplication factor and relatively low seeding rate such as maize are more attractive to the formal sector contrast to grain legumes which has low multiplication factors and high seeding rates. Furthermore, Horward *et al.* (2000) also found that factors which affect seed demand from off farm include farmer ability to produce and save seed, type of crop (self-pollinated, open-pollinated, root or tuber), yield/quality advantage of purchased seed, cost of seed (purchase plus transport costs), price/availability of complementary inputs, relative price of crops, farmer forecast of weather conditions and output prices. Table 6 summarizes important features of hybrid, OPV and self pollinating varieties. Wekundah (2012) found that improved seeds of crops which did not attract commercial seed traders such as beans were efficiently distributed through informal seed system than formal system in rural areas.

Table 6: Important features of hybrid, OPV maize and beans seeds

Features	Hybrid maize	OPV maize	Beans
Breeding system	Forced out pollination	Aggressive cross pollination	Self Pollination
Average sowing rate per ha	Medium (20–35 kg)	Medium (20–35 kg)	High (100 kg)
Multiplication factor	High	High	Medium
Rate of deterioration	Very rapid	Potentially rapid	Very slow
Type of deterioration	Genetic (increased homozygosity)	Seed acquires genes from other maize varieties unless field is isolated	Pollination occurs within the plant, creating genetic stability
Frequency of purchase (average)	Annual	2-3 years	Variable

Source: Lanteri and Quagliotti (1997)

2.4 Rationale of Farmers Seed Demand

Demand theory suggests that consumers of any commodity are rational. Experience shows that the low price of seeds influences farmer to buy seeds from a particular source (Kugbei and Shahab, 2007). Low purchases of improved seed in Tanzania have been due to high costs of seed (Mtolera, 2001). Whereas seed consumers are poor and quality seeds have been sold at higher prices and higher transaction cost are associated with seed purchasing (Minot *et al.,* 2007). As a result during the dry season, farmers use traditional storage techniques to create food stocks to bridge the recurrent 'hunger period' and eventually retain sufficient grains for the next cropping season seeds. However, the traditional storage facilities do not keep this surplus produce long enough. Insects, rodents, humidity and physical damage cause losses of up to 45 % within 6 months

(Steiner, 2010). Despite maize production from the central zone being relatively limited, the region's farm households can provide surpluses and part of which is used as seeds for next season (Temu *et al.*, 2011).

Distance from seed supplier affect seed buying behaviour but farmers who are far from input suppliers tend to grow maize OPVs, as the grain they harvest may be replanted as seed without significant yield loss since OPV seed may be recycled for a maximum of three seasons without significant yield loss (Sentimela and Kosina, 2006). So local suppliers are generally less expensive and offer more dependable service than those located at a distance. QDS production and supply is localized to an area of one ward (Granqvst, 2009; MAFC, 2001) therefore removing distance barriers for farmers to access quality seeds. Delivery may be more prompt because the distance is shorter and there is less likelihood of transport delays. More importantly, local suppliers gain greater knowledge of their customers' needs and may be more flexible in meeting their requirements (Batt, 2000b).

Limited availability of credit, reduced production of certified seed by the seed companies relative to demand where some seed companies have resorted to seed importation, the tendency of seed companies not to sell seed crops that are important for farmers and new varieties produced by the national research system are not bought and disseminated by seed companies (Mtolera, 2001). QDS scheme can work with minimum support (FAO, 2006; Granqvst, 2009). However, lack of strong supporting institutions and infrastructures such as irrigation, credits and extension service has negatively affected seed production in Tanzania (AGRA, 2010). It has been advised that all farmers in the QDS production area are in a close contact with other stakeholders in the seed chain, wholesalers, grain and final product buyers (Granqvst, 2009).

The trust that farmers place in most preferred seed suppliers, the more often the seed supplier met the farmers expectations, the greater the cooperation between the seed supplier and the farmer and the greater the benefits that the farmer could obtain by maintaining their relationship with their seed supplier (Batt, 2000). ICARDA (2009) documented that it is essential to build up a sustainable QDS production to secure that a crop and a variety can be sold in the area; and that QDS producers know their customers (market) well. Also for sustainability of QDS production, it is also essential that each trained producer has a partner or an associate who will take over the seed production in the village, if the seed producing farmers are not able to continue with the seed business (ICARDA, 2009). The more often farmers can buy seed from a supplier either because of good quality or trustworthiness, the better is the business potential for that supplier but it is expected that farmers buying new quality seed will continue to multiply this seed for some years before renewing it (Kugbei and Shahab, 2007).

2.5 Partial Equilibrium of Rural Seed Market with QDS

Partial equilibrium analysis (PEA) examines the effects of policy action in creating equilibrium only in that particular sector or market which is directly affected, ignoring its effect in any other market or industry assuming that they are being small will have little impact if any (Mandal, 2007). Partial equilibrium models simulate one component of the economy, such as one commodity or the agricultural sector. Income is at least partly exogenous. By contrast, a general equilibrium model includes all sectors of the economy and income is fully endogenous (Minot, 2009).

Basically, PEA is the core of markets theory in economics and it applies to one market of a specific private good or service and the traders involved in the market are divided into two groups; consumers (demand side) and producers (supply side) sides of the market.

Supply and demand are two indispensable parts of the market derived from the willingness of sellers and buyers respectively therefore in PEA the main goal is to determine how supply and demand interacts to determine the way the market allocates society's resources. The concept of PEA uses graphical illustration of the market with the assumption that any disturbance to either demand or supply will alter the market equilibrium (Wang and Stanley, 2006).

In PEA the state of a market can be sorted into three cases as follows. First, when quantity demanded is equal to quantity supplied, namely, the market is in equilibrium. In this case, the market price is called equilibrium price or market-clearing price. Second, when quantity demanded is greater than quantity supplied, namely, the market is in shortage. Third, when quantity demanded is less than quantity supplied, the market is in surplus (Wang and Stanley, 2009).

One of key policy intervention instrument to promote use of improved inputs in Tanzania is National Input Voucher scheme (Masalawala, 2009). Package of NAIVS are distributed to selected farmers in selected districts. NAIVS package for one farmer consist of three input subsidy vouchers for one bag of urea, one bag of DAP/Mijingu and improved maize or rice seed. Each input voucher worth 50% of price and other 50% are co-financed by farmers (Minot, 2009). It is obvious that NAIVS subsidy have effect on QDS scheme because seed is among the inputs supplied through NAIVS subsidy scheme. Minot (2009) recommends use of equilibrium analysis technique to analyse such effects of different policies on agricultural marketing.

It is assumed that seed market is perfectly competitive in the rural Kongwa and Siha Districts respectively in a short run. Farmers own-saved seeds constitute the largest supply of seeds in seed market and it is where most of farmers obtain seeds at lowest price (P_{FS}) for seed market to be in equilibrium (Fig. 1). Formal supply and demand for certified seeds in the market is inelastic (Waithaka, 2011) and there have been shortage of supply and distribution channels to rural areas which force more than 90% of farmers to rely on farmers own saved seeds which are the cheaper price (P_{FS}) compared to certified seeds (P_{CS}) (URT, 2012) (Fig.1). It is obvious then that farmer tends to use locally produced seeds from previous saved seeds more than certified seeds because they are cheaper compared to certified seeds. According to FAO (2006) QDS scheme offers seeds at cheapest price compared to a formal seed scheme (certified seeds) forming the most reliable source of quality seeds linking informal and formal system. So having QDS in the market fill the gap between formal and informal seeds (Granqvst, 2009) and therefore it is clear that QDS should be more elastic than certified seeds but less elastic compared to farmer saved seeds and should be sold at price (P_{QDS}) which is higher than farmer saved seeds (P_{FS}) but lower than certified seeds (P_{CS}) (Fig. 1). Based on PEA concept it is clear that having the highest price of certified seeds among seeds available in the market, use of certified seeds is the lowest of the other two sources of seeds; farmer saved seeds have the lowest price of all other sources and since seed consumers in SSA are poor (Minot, 2009) they are expected to be highly relying on farmer saved seeds. QDS fall between formal and informal seed system, QDS prices are expected to fall between certified and formal seed system. It can then be concluded that if $P_{CS} > P_{QDS} > P_{FS}$ then $Q_{FS} > Q_{QDS} > Q_{CS}$ and vice versa.

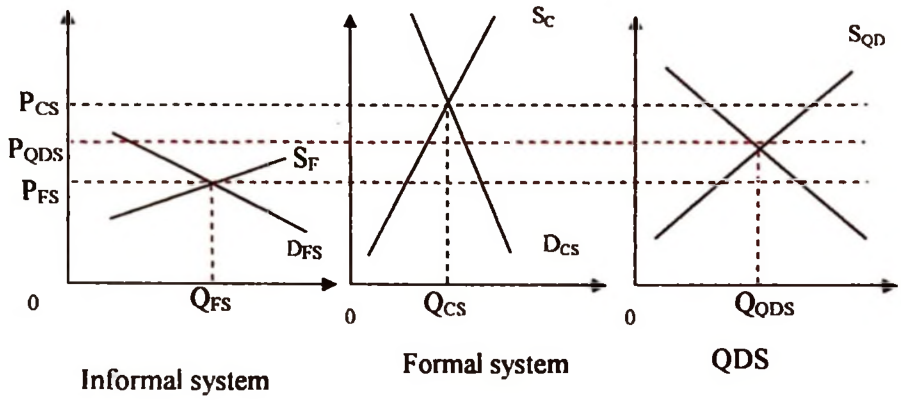


Figure 1: Partial equilibrium of rural seed market

CHAPTER THREE

3.0 METHODOLOGY

3.1 Conceptual framework

Farmers are known for saving their own-saved seeds after harvesting, large part of such harvest is sold to grain market to get cash or stored for food security or sold later at higher price. This study started by considering the broad perspective of seed industry and it narrowed down to study QDS market. Therefore the conceptual framework for analysis of QDS demand start from farmers who always demand seeds which they get from own saved seeds, other farmers or local market in informal seed delivery system as in Minot (2008). Some of farmers buy certified seeds every season while most of them buy seeds when they want new variety to replace recycled seed, demand for certified seeds lead farmers to purchases seeds from agro dealers in formal seed system (Cromwel, 1996). Demand for certified seeds is, however, low due to higher costs of seeds (Minot *et al.*, 2007). QDS scheme address the gap between formal and informal seed delivery system to form a reliable and affordable source of seeds for small scale farmers within their locality (ICARDA, 2009; Granqvst, 2009).

Figure 2 illustrates the conceptual framework used for designing this study by considering three sources of seeds (formal, informal and QDS) competing in rural market. It is obvious that seed and other planting materials is a basic input for any crop production. So all farmers have demand for seeds because no farmer can be in production without seeds (Fig. 2). There are several factors which influence farmers demand for seeds from specific sources (Fig. 2). Economic theory suggests demand as a function of price, budget, price of substitutes and individual characteristics. Other factors include use of accompanying inputs such as fertilizer and pesticides, age of household, marital status of household head, household decision maker, economic status of household, association membership, awareness, seed quality, variety, and access to credit (Kugbei and Shahab, 2007; Temu *et al.*, 2011). Such factors influence farmers to choose seeds from informal sources; formal source or QDS suppliers (Fig. 2).

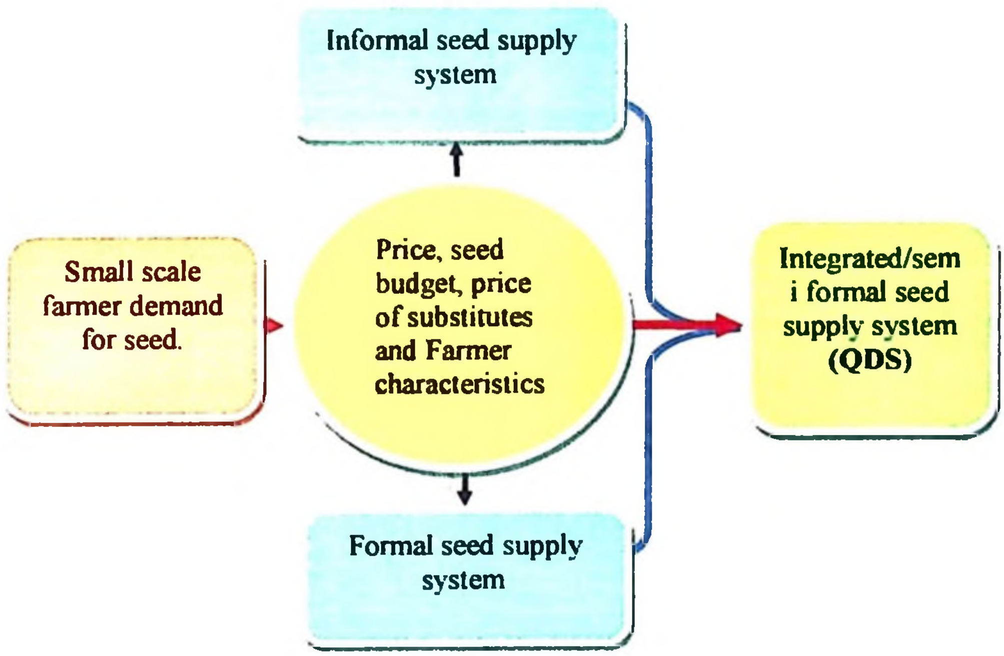


Figure 2: Conceptual framework of seed market with QDS supply

3.2 Study Areas

Maize and common bean are the major food crops of smallholder farmers in Tanzania. It is estimated that over 75% of rural households in Tanzania depend on maize and beans for daily subsistence (CIAT, 2008). According to 2008/09 agricultural census report URT, 2012) Kongwa and Siha constitute among areas with high potential maize and bean production respectively. The districts are among the district with QDS production programmes. In both districts small scale seed production was introduced by on-farm seed production Collaborative Research Support Programme (CRSP) implemented in 1990s to early 2000s (Mtenga *et al.*, 2001).

3.2.1 Kongwa district

Kongwa District is one of the six Districts of Dodoma Region others are Bahi, Chamwino, Kondoa, Mpwapwa and Dodoma Municipal. The district capital is Kongwa township. The district has the largest grain market in the country at Kibaigwa town. According to 2012 national population census report, Kongwa District has 22 wards and population of about 309 973 with an average household size of 5 members per household making a total of about 61 995 households. According to 2008/09 agricultural census report about 57 % of Kongwa District residents depend on crop farming. The total arable land for agriculture in the district is 363 691 hectares but only 258 690 hectares are under cultivation. There is a total of 5 811 hectares of land which can be used for irrigation, but only 295 hectares are cyclically cultivated using traditional canal irrigation. The average area utilized per household was 3.9 hectares within which 2.4 are average hectares of maize. The district is the highest maize producer in Dodoma Region (URT, 2012). Other food and cash crops grown include millet, groundnuts, cassava, sunflower, beans and horticulture crops.

Table 7: Trend of maize production in Kongwa district

Year	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11
Ha	64 421	64 421	56 818	56 840	61 482	61 482
Tons	80 402	27 264	76 867	7 756	30 741	30 741

Source: Kongwa DALDO office

According to Kongwa District council agricultural reports (Table 7) maize production has been increased due to the large increase in the planted area and not due to increased productivity and decrease in production has been highly attributed by draught.

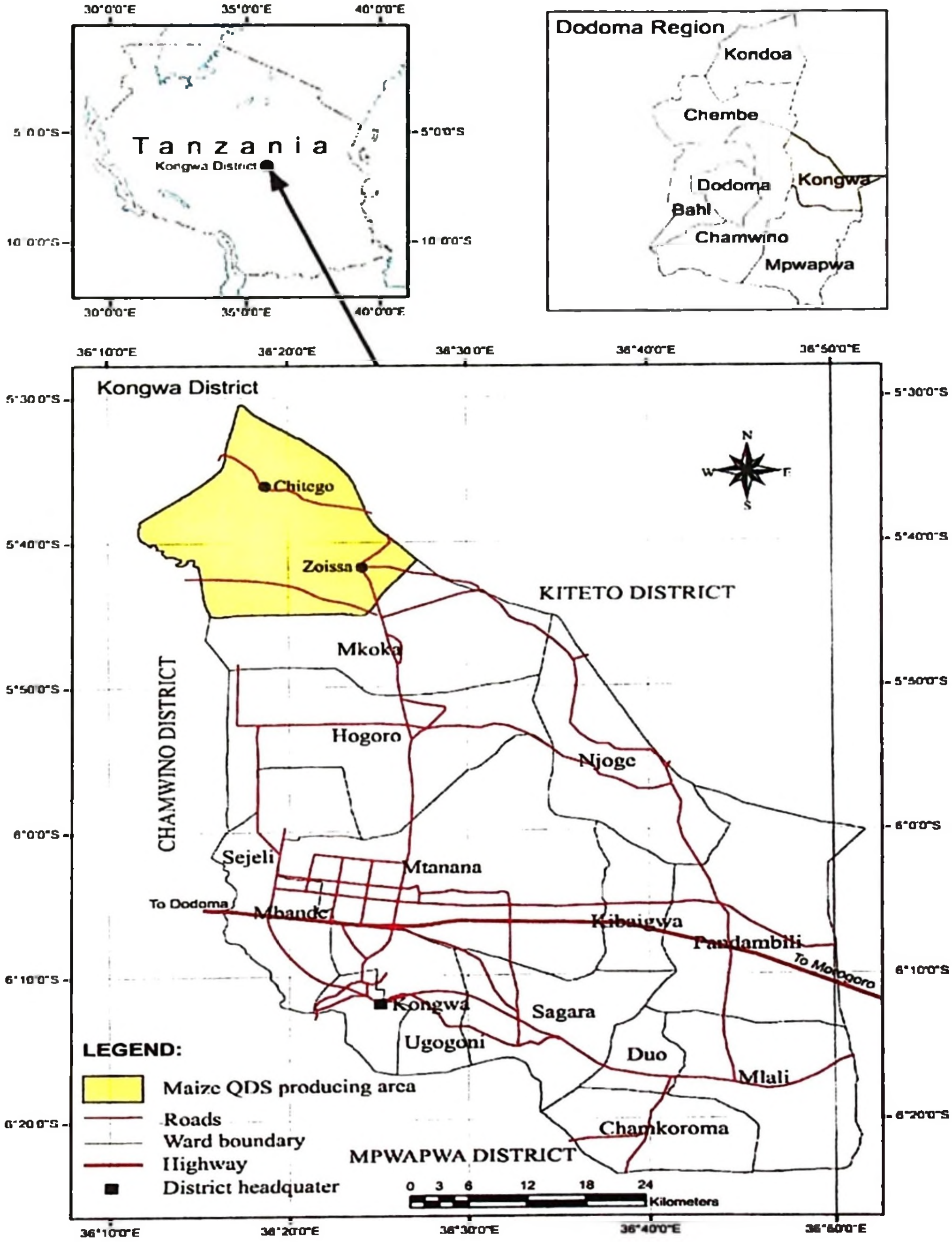


Figure 3 Map of Kongwa district

3.2.2 Siha district

Siha is among seven districts of Kilimanjaro Region, other districts are Hai, Moshi municipal, Moshi rural, Same, Mwanga and Rombo. It was established on 1st July 2007 from Hai District. District size is 1158Km^2 in which 80% are arable land for agricultural activities. The district has five subdivisions, 12 wards and 37 villages. Siha District has two agricultural production seasons per year. According to 2012 national census report, Siha District has population of about 116 313 with an average of 4 members per household (URT, 2012). District annual rainfall ranges between 500 mm and 1 200 mm. Crops produced are coffee, maize, beans, sweet potatoes, vegetables and fruits. Bean crop is among main source of income for farmers in the district. Table 8 shows the trend of beans production in Siha District.

Table 8:Trend of beans production in Siha district

Year	2007/08	2008/09	2009/10	2010/11	2011/12
Ha	5 563	2 089	4 800	8 905	9 391
Tons	6 301	105	5 760	13 358	11 269

Source: Siha DALDO office

Trend of beans production (Table 8) in Siha District shows more allocation of land for bean production in the district due to increasing demand for beans from the district. However, high beans production in the district has been due to the large increase in the planted area and not due to increased productivity. Drought is among the major factor hindering production of beans in the district.

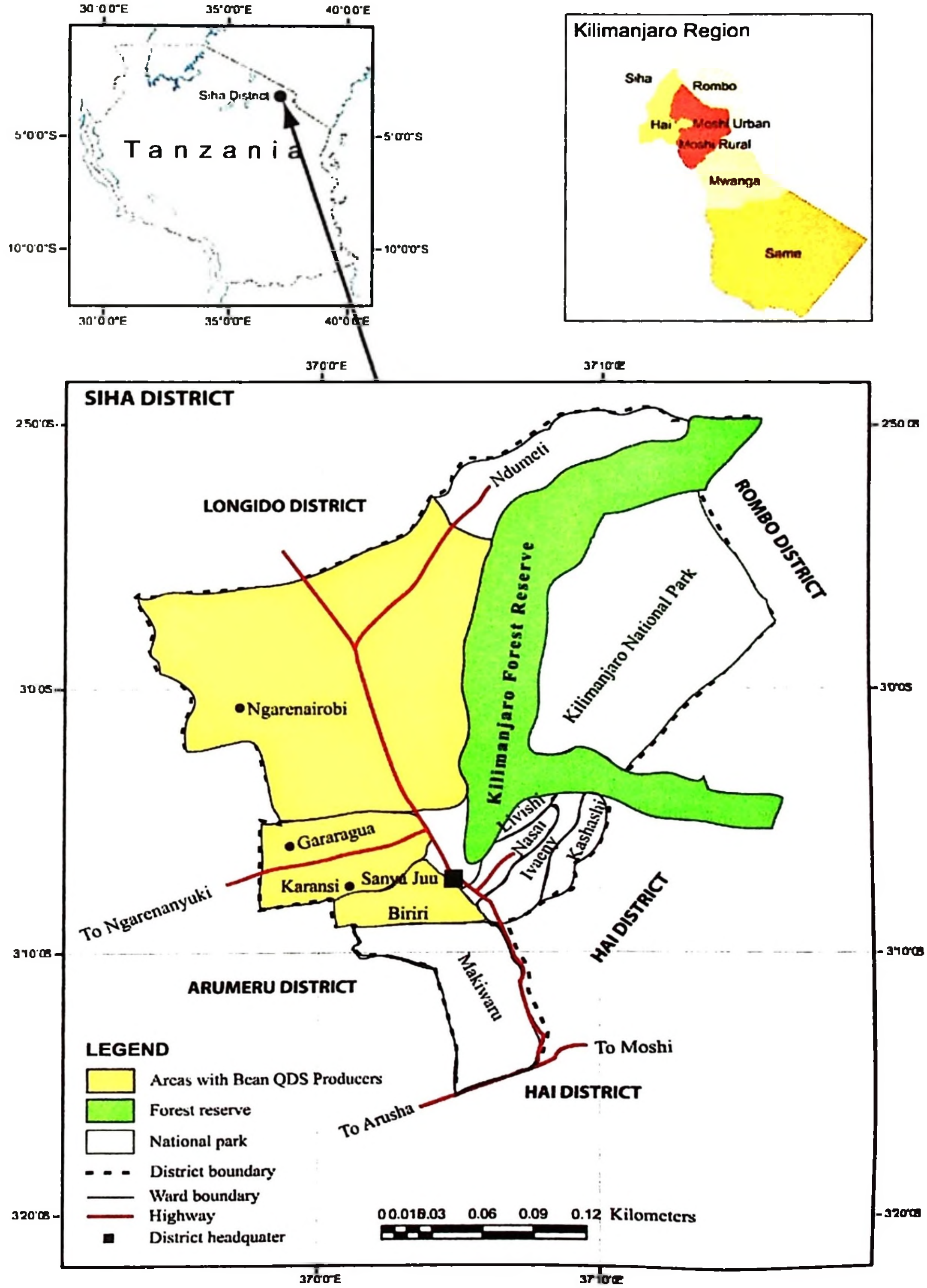


Figure 4: Map of Siha district

3.3 Study Design

This study was cross sectional designed and data were collected in October and November 2012. Data were gathered from farmers, SNAL, agro dealers, village reports, district report and from electronic sources as well as from different publications.

3.3.1 Sample size

This study involved a total of 240 respondents (120 from each district) randomly selected from maize and bean producers in Kongwa and Siha Districts respectively. Each study area represented market for QDS of one crop whereby Kongwa represented market for maize QDS and Siha represented market for beans QDS. It has been documented that sample size with at least 120 observations to be sufficient for having good analysis (Bartlett, 2001). For the purpose of having a good analysis, data from 120 respondents of each crop were collected.

3.3.2 Sampling procedures

Sampling was done firstly by identifying target population. These are villages within wards where QDS have been produced in Kongwa and Siha Districts. These villages were used to construct sampling frame of maize and bean producers respectively. Thirty respondents were then selected randomly from each village. A total sample of 240 respondents was then obtained, 120 from each district respectively (Table 9).

Table 9: Distribution of respondents

District	Wards	Villages	Crop	Number of respondents
Kongwa	Chitego	Chitego	Maize	30
		Ngutoto	Maize	30
	Zoissa	Pingalame	Maize	30
		Zoissa	Maize	30
		Total		120
Siha	Ngarenairobi	Namwai	Beans	30
	Karansi	Karansi	Beans	30
	Gararagua	Magadini	Beans	30
	Sanyajuu	Sanyajuu	Beans	30
		Total		120
Total				240

3.3.3 Tools for data collection

a) Collection of primary data

The primary data forms an important component of any research investigation. This study focuses on the seed supply to farmers and the farmers demand for QDS and the behaviour of farmers towards QDS use. In addition QDS producers, input stores, market seed vendors and rural shops were also important and their primary data were essentially elicited. The primary data was collected using a pre-structured questionnaire encompassing a number of variables/parameters which explain their behaviour towards purchase of seeds. Other tools for primary data collection were interview, focus group discussion and observation from farmers, market seed vendors, input suppliers, local shops, ASA officers, TOSCI officers and seed producers.

b) Collection of secondary data

Secondary data required were collected from reports from districts department of agriculture, TOSCI, ASA, NGOs and SNAL. Other relevant information was also gathered from different publications as well as electronic sources.

3.3.4 Data handling

From questionnaires and other data collection tools data were entered into the Statistical Package for Social Science (SPSS) version 16 and MS Excel 2007. Missing values were replaced by figures which were not among any figure in the observations in the variable as recommended by Field (2005) instruction on how to deal with missing value in using SPSS. Cox and Wohlgenant (1989) recommend substituting missing prices for individuals who did not use a commodity by appropriate sample means. SPSS version 16 has an option of replacing missing value by mean value (Field, 2005). In this case substituted price mean reflect opportunity costs household incurred for not using particular seed type or source of seeds.

3.4 Tools for Data Analysis

a) Determination of proportion of seeds from different sources

Extent of farmers use of seeds from specific source can be measured by percentage of seeds used from such source (Ayieko and Tschirley, 2006; Kizito, 2011; Kugbei and Shahab, 2007). Measurement of share in the market is among indicators of performance of specific industry (FEWS, 2008). Furthermore generalized sales (volume and value), sales trends, market share (volume and value), market trend, Number of customers, number of new customers, availability and price are among key market performance measures (Grønholdt and Martensen, 2006). Performance of seed systems have been mostly measured by share percentage of seed use from each system from total seeds used by the household. The indices computed using equation 4, 5 and 6 were then compared.

$$S_{CS} = \frac{\Sum Q_{CS}}{\Sum Q_T} \text{ X } 100 \quad \ldots\ldots (4)$$

$$S_{QDS} = \frac{\Sum Q_{QDS}}{\Sum Q_T} \text{ X } 100 \quad \ldots\ldots (5)$$

$$S_{FS} = \frac{\Sum Q_{FS}}{\Sum Q_T} \text{ X } 100 \quad \ldots\ldots (6)$$

The number of sources of seed may change but following condition (Equation 7-9) must be met in using the above equation (Equation 4-6);

$$\Sigma Q_T = \Sigma Q_{CS} + \Sigma Q_{QDS} + \Sigma Q_{FS} \quad \text{.......... (7)}$$

$$\frac{\Sigma Q_{CS} + \Sigma Q_{QDS} + \Sigma Q_{FS}}{\Sigma Q_T} = 1 \quad \text{..........(8)}$$

$$S_{CS} + S_{QDS} + S_{FS} = 100 \quad \text{..........(9)}$$

Where; S_{QDS} = Share of quantity of QDS used sources;

S_{CS} = Share of quantity of certified seeds used sources;

S_{CS} = Share of quantity of farmer saved seeds used sources;

ΣQ_{QDS} = Total quantity of QDS used;

ΣQ_{CS} = Total quantity of certified seeds used;

ΣQ_{CS} = Total quantity of farmer saved seeds used;

ΣQ_T = Total quantity of seeds used (Equation 7).

This approach was also used by Ayieko and Tschirley (2006) in Kenya and Kugbei and Shahab (2007) in Afghanistan to study seed market. In this study it was assumed that the presence of QDS in the rural seed market would offer quality seeds at affordable price and at place proximity to the farmers and therefore the demand for QDS would be higher and as a result there would be a higher percentage share of QDS in seeds used in the study areas.

b) Determining factors influencing farmers to purchase QDS

A binary logistic regression model has been widely employed to determine factors affecting the use of technology in several socioeconomic studies (Katungi *et al.*, 2011;

Temu *et al.*, 2011). The logistic regression model assumes an underlying adoption latent variable Y whereby exogenous variables are hypothesized to influence adoption decisions. Variation in likelihood of use is a more relevant measure of factors influencing buying of a particular commodity (Field, 2005). Independent variable such as age, family size, years of formal schooling of household head, borrowing habits of household head, visiting demonstrations, the availability of markets, attending training, perception of household head and knowledge of household head that helps in addressing practical questions of use and not using a particular commodity or technology (Keil and Nielsen, 2012).

A logit analysis regression model predict the logit, the natural log of the odds of having made one or the other decision, the predicted probability of the event which is coded with 1 (continue the research) rather than with 0 (stop the research), is the predicted probability of the other decision, and X is our predictor variable (Equation 10).

$$\ln(\mathrm{ODD}) = \ln\left(\frac{Y}{1-Y}\right) = a + bX_{is} \quad \text{.......} (10)$$

Logistic regression does not make any assumptions of normality, linearity, and homogeneity of variance for the independent variables (Madnan, 1990). It uses maximum-likelihood estimation to compute the coefficients for the logistic regression equation. The Wald statistic and associated probabilities provide an index of the significance of each predictor in the equation. The Wald statistic has a chi-square distribution.

b) Model for estimating demand for QDS

The focus of this analysis is on the demand for QDS, so QDS are assumed to be weakly separable from all other accessible sources of seeds. We consider the translog demand system, derived from the translog indirect utility function adopted from Cobb Douglass utility function (Equation 11).

$$Q_i = AY^m P_i^{e_{ii}} P_j^{e_{ij}} X_n^x e^{D_n} \quad \text{.......} (11)$$

Transforming equation (11) into the linear equation in order to use OLS regression in the analysis we get equation 12 which is in a form in a similar way as used in Latif *et al* (2012) and it is an appropriate technique for factor demand estimation (Varian, 1992).

$$\ln Q_i = \alpha + m \ln Y + e_{ii} \ln P_i + e_{ij} \ln P_j + x \ln X_n \ldots + dD_n + \mu \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(12)$$

Where Q_i is quantity of QDS used by farmer, Y is household income, P_i is QDS price, P_j is alternative seed sources price, X_n are other continuous independent variables, D_n are qualitative independent variables, m, e_{ii}, e_{ij} and x are elasticity coefficients, d are other slope coefficients and μ is error term. It is assumed that farmers are facing competitive markets for the output and inputs. the prices are outside of the control of the farmers (Varian, 1992). Using OLS regression model assumed that the error term is normally distributed with zero mean, constant variance (homoscedasticity), non-auto correlated and uncorrelated with independent variables therefore OLS is an appropriate estimation technique (Madnan, 1990; Varian, 1992; Woodridge, 1999).

CHAPTER FOUR

4.0 RESULTS AND DISCUSION

4.1 Respondents Characteristics

Table 10 summarizes characteristics of randomly selected respondents in percentages by gender, age group, education level, off farm income, membership of agrarian institutions, access to extension service and credit.

Table 10: Respondent characteristics

Respondent characteristics		% of maize producers (n=120)	% of beans producers (n=120)
Gender	Men	63	70
	Women	37	30
Age groups	20-29	6	5
	30-39	33	22
	40-49	45	43
	50-59	12	22
	60-69	3	8
Education level	Not able to read and write	5	5
	Primary education	85	69
	Secondary education	5	20
	Post secondary education	5	6
Have off farm income	Yes	33	32
	No	67	68
Membership in associations	Yes	51	76
	No	49	24
Access to extension services	Yes	53	62
	No	47	38
Access to credit	Yes	45	39
	No	55	61

i) Gender

Men were the highest percentage of randomly selected respondents (Table 10). However, it has been found 18% of women respondents bought maize QDS in contrast with 26% of men who bought maize QDS. QDS scheme has been operating effectively in maize production but previous efforts to establish bean QDS was not sustained compared to maize QDS in the study areas but there were new bean QDS producers producing bean seeds for sale in 2013. It was also found in both crops in respective districts that all women were willing to buy QDS while some of men were not willing to buy QDS in next seasons (Table 11). This finding is similar to Lyimo (2006). Furthermore, other studies indicated that despite a higher proportion of the contribution of women than men labour in agricultural sector they are not active in decision making and therefore they have not been using some technologies despite of their interest to do so (Satyavathi *et al.,* 2011; Juma *et al.*, 2009).

Table 11: QDS use by gender

Crop	Maize		Beans	
	Male	**Female**	**Male**	**Female**
Gender of household head				
Percentage of farmers used QDS in 2011/12 (n=120)	26	18	0	0
Percentage of farmers willing to buy QDS (n=120)	94	100	90	100
Percentage of farmers not willing to buy QDS (n=120)	6	0	10	0

ii) Age

In this study highest percentage of randomly selected maize and bean producers were aged between 40-49 and 30-39 followed by 50-59 whereas people aged between 20-29 and above 60 formed fewest percentage of both maize and bean producers (Table 10).

Whereas QDS market consists of people of all age groups categorized in this study, it was found that all QDS producers are within 30-49 years. Bossuroy *et al.* (2007) documented that higher proportions of youths and middle aged people in agriculture as an indication of the important role of agricultural sector in absorbing rural labour force. Maize and beans are among the crops ranking high in terms of production and consumption (MAFC, 2012) in Tanzania therefore provides an important employment opportunity for youth.

iii) Education

From randomly selected sample of respondents it was revealed that most of maize and bean producers have a primary school education; followed by secondary education where as only few have post secondary education (Table 10). Most of the farmers have formal education and therefore able to read and write. This finding is similar to Lyimo (2006) that the majority of farmers are able to read and write due to primary education. Ability to read and write induce continuum of learning in enabling individuals to achieve their goals, to develop their knowledge and potential, and to participate fully in their community and wider society (Farmer and Stricevic, 2011). However, despite of farmers ability to read and write the big problem is on how to free themselves from subsistence farming to be able to learn and practice improved technologies (Paul, 2007). Therefore an ability to read and write for most of maize and bean producers in Kongwa and Siha induce them an opportunity to learn, understand then improve their farming through participating in QDS production, marketing and use in crop production.

iv) Off farm activities

Most of maize and bean producers in the study areas depend fully on agriculture as the source of their livelihood while some of the farmers have off farm sources of income

(Table 10). Off farm sources of income include employment in public and private institutions and non agricultural enterprises such as shops. Some farmers diversify their source of livelihood strategy as a coping strategy against risks associated with rain fed agriculture and to maximize use of labour during off season (SUA, 2007).

High dependence on rain fed agriculture lead farmers to adopt risk-reducing activities which reduce their dependence on agriculture. In such situation poor farm households in rain-fed and risky production environments become reluctant to adopt new farm technologies with potential production gain because, at the same time, they involve enormous downside risks (Juma *et al.*, 2009). Experiences of previous studies show that QDS production and market is threatened by dependence on rain fed agriculture. In such situation most of income generated from agriculture is allocated for investment in off farm businesses. Household lower budget on agricultural inputs lead to low expenditure on seeds and other inputs thereby affect farmers QDS demand.

v) Membership to farmers associations

In this study it has been found that most of maize and bean producers have joined farmers associations available in their localities (Table 10). Such farmers associations are mainly Cooperative societies, SACCOSS, VIKOBA and farmers group. In Siha District where there is coffee production some farmers were member of Cooperative societies of coffee producers from which they also obtain benefits such credits and trainings in production of other crops. However, some farmers are still reluctant to join farmers associations either because they were not involved in their formation, have quitted due to conflicts or did not understand the benefits of becoming members. It was found that most of maize and bean producers who are members of farmers associations were willing to buy QDS in next seasons (Table 12). This finding is similar to Lyimo (2006) that extension staff and other supporting institutions have been interested in working with farmers in groups and therefore farmers in groups have been easier for them to adopt and use available technologies. Therefore farmers associations are among the easier way through which QDS can be marketed to farmers.

Table 12: QDS use and membership in associations

Crop	Maize (n=120)			Beans (n=120)		
	Yes	No	Total	Yes	No	Total
Willingness to buy QDS						
Percentage of members	97	3	100	100	0	100
Percentage of non members	85	15	100	79	21	100

vi) Extension service

More than half of randomly selected respondents of this study had a contact with public or private agricultural extension agent at least once in 2011/12 season for advisory service. It has been found in this study that 31% of farmers who used maize QDS in Kongwa had at least one contact with extension agents in 2011/12 season. Furthermore most of the farmers who contacted extension agent were willing to buy maize and beans QDS in next seasons (Table 13). According to Tanzania agricultural census survey extension services reached about 67.5% of the agriculture households in the Tanzania (URT, 2012) and it has been documented that closer links between applied research and farmers on the ground, through the extension system or other channels to promote the use of technologies (Kassie and Zikhali, 2009). So the improvement of extension services is among way through which QDS can be promoted for maize and bean production.

Table 13: Percentage of farmers with access to extension service

Crop	Maize (n=120)	Beans (n=120)
Percentage of farmers with contact with extension agent willing to buy QDS.	97	95
Percentage of farmers with contact with extension agent but not willing to buy QDS.	3	5
Total	100	100

vii) Agricultural credit

Most of farmers had not ever got an access to agricultural credit. Limited number of credit providers and lack of collateral to secure credits are among constraints which hind maize and bean producers from accessing agricultural credits. It has been found in this study that about 43% of all maize producers who bought maize QDS in 2011/12 had ever accessed agricultural credit either through a bank or SACCOS. Furthermore it was found that most of the farmers who had ever taken credit were willing to buy QDS (Table 14). A lack of credit and risk-sharing institutions reduce the likelihood that farmers adopt technologies (Mc Intyre *et al.*, 2009). Among institutional factors that limit adoption of technology is lack of markets for credit because of high risk of rain fed crops failure (Liberio, 2012). Though none of farmers bought QDS through the credit schemes, it has been documented that accesses to credit promote the use of improved inputs (Masalawala *et al.*, 2010) such as improved seeds as QDS. However, QDS is easier to access that even with or without a credit scheme associated with QDS, small scale farmers can afford to acquire quality seeds in their locality.

Table 14: Percentage of farmers with access to credit

Crop	Maize (n=120)	Beans (n=120)
Percentage of farmers with access to credit willing to buy QDS.	96	92
Percentage of farmers with access to credit but not willing to buy.	4	8
Total	100	100

4.2 Performance of Seed Supply Systems in Ensuring Seed Security

4.2.1 Performance of maize seed system

Maize seed delivery is done through formal, semi formal and informal systems. However, dependence of farmers on each system vary depending on prices of seeds, proximity to suppliers, individual preference, availability and quantity demanded by farmers. Formal, informal and integrated formal seed systems operate together in rural seed market. Sources of seeds in formal system were National Agricultural Inputs Voucher System (NAIVS) agents, input stores and NGOs; Sources of seeds in informal seed system were own saved seeds and other farmer and Quality Declared Seed in integrated seed system (Table 15).

Table 15: Share of seeds from different sources of maize seed

Seed system	Sources of seeds	Unit used for measurement	Price	% of farmers (n=120)	Weight share (%)
Formal system	NAIVS	Kg	1000	58	9.0
	Input supply stores	Kg	2000 to 4000	2	0.1
	NGO	Kg	Free provided.	2	0.1
Informal system	Own saved	*Tin of 20 litres	7000 to 10 000	70	69.9
	Other farmer	*Tin of 20 litres	Barter trade or 7000-10 000	20	5.9
Semi formal	QDS producers	Kg	1250	23	15.1
Total	**N/A**	**N/A**	**N/A**	**N/A**	**100**

*1tin of 20litres is approximately equal to 20Kg, Total quantity of seeds used = 9208
N/A=Not Applicable.

a) Formal maize seed system

Only 9.2% of maize seeds used in 2011/12 were obtained through the formal seed system in Kongwa District. Government, seed companies, input suppliers, NGOs and farmers are the main actors in this system. Fifty eight percent of farmers benefited from NAIVS the most important formal source of seeds through formal system but it contributed only 9% of maize seeds planted in 2011/12. The second source is unsubsidized maize seed where only 2% of farmers bought unsubsidized maize seeds from private input suppliers and constituted only 0.1% of all planted seeds in 2011/12. Three percent (3%) of farmers used 0.1% of all hybrid maize seeds that were provided freely by through seed kit programmes by NGOs. Farmers dependence on maize seeds through formal system is heavily relying on government subsidy through NAIVS in the study areas. According to Asfaw *et al.* (2008) the very limited numbers of private seed enterprises and the low attention accorded to the informal seed sector narrowed the options available to farmers for obtaining quality seeds at affordable prices at the right place and time. Limited coverage of the formal seed distribution system remains one of the serious problems limiting availability of affordable seed in remote areas (AGRA, 2010). Heavy reliance on seed subsidy create a rigid sealed system which cannot meet the seed needs for diverse groups of farmers and discourage commercialization of small scale seed production through QDS scheme.

Dependence on NAIVS for quality seeds was not providing enough seed for commercial maize production because each small holder farmer were given only 10Kg of maize seeds which was sufficient for 0.4ha (1 Acre) only per household (HH). This system provided maize seeds for only 10% of an average hectare of maize per household since an average land allocated for maize production was 4hactres (10 Acres) per household.

Approved input stores for buying seeds are allocated in few small towns of Mkoka, Kongwa and Kibaigwa. Limited number of input stores in rural areas limits farmers from accessing quality maize seeds (Asfaw *et al.*, 2008). Despite of the important role of private sector in deliverance of quality seeds, price of maize seeds through it is higher for small scale maize growers to buy seeds. It ranked lowest in terms of weight of seeds and the number of farmers used it in 2011/12.

Maize seeds aid through NGOs form another important source of seeds for maize producers but this source is not reliable because only few farmers benefit from it by receiving a very small amount of seeds through seed kit programmes. Generally, during this study period formal seed systems were not providing enough maize seeds for farmers as it ranked lowest in terms of the total amount of seeds to farmers while it is the most trusted source of quality seeds.

b) Informal maize seed system

The informal seed delivery system forms the main source of maize seeds. Own saved seeds were used by 70% of farmers and 69.9% of all maize seeds planted by respondents. Own saved seeds form the largest part by percentage of farmers and by weight of maize seeds use. The second means of source of seeds in informal system are neighbours and relatives (other farmers) where 20% of farmers obtained seeds from their fellow farmers and these forms 5.95% of all seeds used by farmers.

It was also found that due to shortage of seeds through formal seed delivery system farmers depend heavily on informal system. Seventy six (76) percent of seeds used in 2011/12 were obtained from informal system. About 65% of farmers who used locally saved seeds did not know the origin of seeds they used. Whereas quality seeds must be certified by TOSCI all seeds obtained from informal seed system were not quality seeds. Farmers were only able to identify the origin of recycled seeds obtained from either local varieties, NAIVS seeds, QDS, previous NGO supported seeds and seeds bought from input stores in previous years. Seed storage from one season to another is done through vihenge, hanging on tree, sisal bags, nylon bags and barrels where only 47% of such farmers treated such seeds with pesticides. Pesticides used for maize seeds treatment are those used for maize storage such as Shumba dust and Actellic super dust. These findings show that infomal seed systems were the highly used sources of seeds despite of their lack of assuarance of seed quality. Similarly, Minot *et al.* (2007) documented that most of small scale farmers in Sub Sahara Africa uses seeds from informal seed system.

c) Integrated maize seed system

Private extension service provider known as Lay Volunteer International Agency (LVIA) established QDS production in Kongwa District in 1997 in Zoissa sub division through schools and farmers group including Zoissa Seed Multiplication group (ZOSEM). Up to 2012 season only ZOSEM group with 10 members was still producing QDS in Kongwa district. This group has succeeded to introduce its QDS brand name Zoissa seeds in Kongwa seed market. ZOSEM group is gender balanced in terms of number whereby both men and women constitute 50% of members. However it is uncertain in this study on whether women are full involved in QDS production and marketing decisions because 80% of members are married couples meaning that men still might influence decision from the family. Furthermore, the study found that among the aim of SOZEM members to be married couples was to ensure the sustainability of the group through making QDS production among members families business.

Use of maize QDS is adopted by 23% of maize farmers living in Zoissa sub division and it comprises 15% of total weight of maize seeds used in 2011/12 season. Maize QDS rank third (23%) in terms of adoption by farmers after own saved seeds (70%) and NAIVS seeds (58%). Adoption of maize QDS in terms of percentage of weighted maize seeds ranked second (15%) after own saved seeds (70%). So maize QDS forms a reliable source of quality maize seeds for farmers because locally saved seeds does assure quality maize seeds.

There have never been noticed surplus of QDS in Kongwa instead there has been deficit due to higher market demand compared to supply. From 2007-2010 there have been an increase in trend of QDS production hectares and supply every year from 2007 to 2011 and decrease was noted in 2012 due to severe drought in Kongwa (Fig. 5).

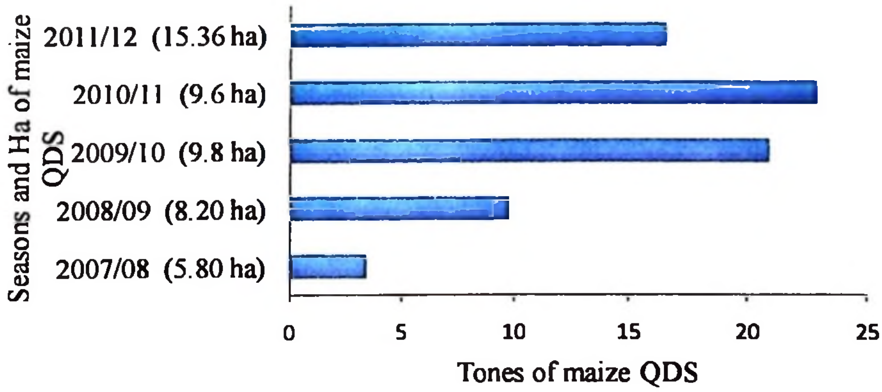


Figure 5: Trend of maize QDS production in Kongwa

An increase shows that QDS producers are responding to QDS demand of previous season by expanding their production. QDS supply has grew from 3.4 tonnes in 2007/08 season up to 22.8 tonnes in 2011 due to increasing demand realized by QDS producer every season (Fig. 5). However such growth was attributed by an increase in hectares of seeds rather than increase in productivity. Despite of increase in QDS hectares there was dropping in maize QDS production to 16.6 tons in 2012 due to drought. Decline of QDS production in the market led to shortage of maize QDS.

Both MAFC (2012) and KDC QDS production report data shows none of QDS produced in 2011/12 remained unsold. However despite of restriction of selling QDS use to be within a ward (Granqvst, 2009; ICARDA, 2009) Zoissa seeds reach farmers within Zoissa, other wards of Kongwa District as well as in the nearby districts of Dodoma, Kondoa, Kiteto, Mpwapwa and Singida through formal as well as informal maize seed distribution channels thereby created a deficit of QDS in a ward. Deficit of maize QDS in 2011/12 was not only due to decrease in QDS production but also how maize QDS are distributed (Fig. 6).

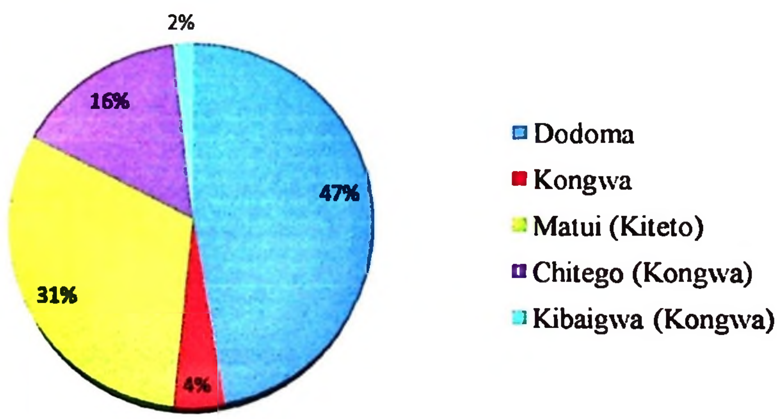


Figure 6: Distribution of maize QDS produced in Kongwa districts

There was distribution of QDS outside legal boundary in Kongwa District due to lack of strong enforcement of seed laws and regulations at district level. Despite of poor seed laws enforcement, Ministry of Agriculture, Food security and Cooperatives have special permit to QDS producers to allow them to sell their seeds beyond one word which ZOSEM did not has during the period of this study.

Fig. 6 shows that only 16% of maize QDS produced in Kongwa in 2011/12 was supplied in the legal boundary allowed for ZOSEM QDS producers to sell their seeds (Zoissa subdivision); Six percent (6%) of maize QDS was distributed to Kongwa town (4%) and Kibaigwa (2%) where by remained seventy two percent (72%) of maize QDS produced were distributed outside of Kongwa District to Kiteto District and Dodoma municipal (Fig. 6). Shortage of improved storage facilities make QDS producers to find market to sell their seeds in bulk to market outside their locality to transfer risks associated with seed deterioration while waiting for local customers. As it was documented by FAO (2010) storage insects are among major threat to stored QDS. A key constraint to marketing of QDS within a single ward is the limited market demand for commercial seeds. Similarly, Tripp and Rohrbach (2001) found single village or ward does not provide enough demand to sustain a viable seed business, while farmer seed enterprises usually can get customers outside their own villages or wards.

4.2.2 Use of maize seeds of different varieties

It was found that 10% of farmers who grew recycled seeds were not able to define which variety of maize they grew in 2011/12. Fifty three percent (53%) of farmers used either local variety known as *Sabatari* and recycled QDS or certified.OPV maize seeds. It was found difficult for such kind of farmers to estimate separately weight of seeds from local varieties used and recycled seeds because they were mixed during planting. It was also found that none of respondent used hybrid varieties were able to define clearly the names of such varieties, for example farmers identified hybrid seeds as SEEDCO, TAN, Pioneer, DK or Pannar seeds rather than Seedco 627, Seedco 513, Seedco 116, Seedco 403, DK 8053, Pioneer PHB 3253, UH 615 and so on (Table 16). Low understanding of hybrid seeds among maize producers who recycle seeds is another threat to genetic purity of seeds in informal seed system in Kongwa District.

It was easier for farmer to remember and identify OPV varieties obtained from either QDS suppliers or NAIVS agents because they are Kiswahili words such as Kilima, Staha and Stuka. The most grown maize variety was Kilima followed by Staha and TMV1 was the least grown OPV variety (Table 16). Among the reasons given by farmers to prefer Kilima were its high productivity compared to other OPV varieties whereby Staha was preferred due to its drought tolerance behaviour. However, still there were very narrow choices for farmers through QDS scheme because only four varieties of maize were produced through QDS scheme. Similary, Olatokun *et al.* (2010) found that few varieties of crop limit farmer range of choice to identify specific varieties suitable for their environment due to poor developed seed industry.

Table 16: Use of different maize varieties in Kongwa

Maize varieties		% of users	Share of seeds (%)
Type	**Varieties**	**(n=120)**	**(9 208 Kg)**
Local varieties and other recycled seeds	Sabatari (red cob maize) and recycled seeds.	53	60.5
OPV varieties	Kilima	38	15.3
	TMV1	10	4.8
	Staha	33	11.4
	Stuka	15	7.9
Hybrid	TAN 250, Pioneer, DKC, KH 500, DK 6031, Panar, SEEDCO	3	0.1
Total		**N/A**	**100**

4.2.3 Bean seed systems

a) Formal seed delivery system

Delivery of bean seeds through the formal system in Siha District has been used only for either introducing new varieties or new generation of specific variety from research institutions. Sokoine University of Agriculture (SUA) and Selian Agricultural Research Institute (SARI) have been known institutions for introducing new generation or varieties of seeds to beans producers. This finding is similar to findings of Hillocks (2006) that in beans certified seed is not available, so that subsequent multiplication and distribution takes place via NGOs, community organizations and farmer to farmer. Furthermore, supply of bean seed through private seed companies is very weak due to strong competition from bean recycled seeds (Minot *et al.*, 2009).

Among nine agro input suppliers surveyed in Siha District at Ngarenairobi, Karansi, Magadini and Sanyajuu input suppliers neither of them had ever sold nor had stock of either certified or uncertified beans seeds. Therefore the formal seed delivery system has been used as source of varieties or for renewing varieties generations only. According to Siha District beans production report among 17 known varieties of beans produced in Siha, only 9 (53%) of them are improved and registered by TOSCI. Up to long rain season of 2012 all nine (9) registered varieties of beans have been under recycling by most of farmers for more than 12 times. However, renewing generation or introducing varieties of bean seeds by research institutions have not formed sustainable system of assuring quality bean seeds in Siha District.

Table 17: List of bean varieties produced in Siha

Seed type	Varieties name
Improved varieties	Lyamungu 85, Jesca/Kijivu, Lyamungu 90, Scliani 94, Seliani 98, Rojo, SUA 90, Pesa, Mshindi
Local varieties	Soya njano, Kiblanketi, Kariasii, Kibukoba njano, Kibukoba zambarao, Nganamna, Masai red/Katuela, Bela bela.

Source: Siha District council beans production report (2012)

b) Informal seed delivery system

Weakness of the formal seed delivery system has resulted in 100% of beans producers to depend on informal seed sources. Seed recycling is the main means of seed production under the informal bean seed scheme. It has been found that for more than 5 years up to 2012 beans seeds of registered varieties have been under recycling without renewal of bean seeds in Siha District. Generally demand for bean seeds at an average seed rate of 70Kg per hectare (28Kg/acre) was 9.4 tons for total of 133 hectares of beans owned by 120 farmers of Siha District in 2012 long rain season. Informal system farmers have four main sources of seeds namely; owns seeds, trade between farmers, shops and market centers. In terms of number of farmers obtained seeds from four sources, own saved seeds rank first (48%), followed by market centres (47%), trade between farmers (15%) and then purchase from shops (3%). Similar finding are obtained if the dependence of farmers is measured in terms of quantity and hectares planted seeds from each source (Table 18).

Table 18: Share of bean seeds from different sources

Source of seeds	% of farmers (n=120)	Beans Ha	% of beans Ha.	Quantity of seeds (Kg)	Share of seeds (% of wt)
Own saved seeds	48	73	55	4 866	52
Other farmers	15	13	10	924	10
Nearby shop	3	3	2	240	3
Market centres	47	43	33	3 324	36
Total	**N/A**	**133**	**100**	**9 354**	**100**

N/A=Not Applicable

It was found that most of farmers depend on own saved seeds and opt for finding seeds from their fellow farmers once their seed storage is exhausted but shortage of seeds from farmers stored seeds happen simultaneously during planting period therefore trade between farmers is not relied by most of beans producers. This force farmers to opt for searching seeds from nearby shops in their locality but limited number of shops in rural areas lead farmers to opt for searching seeds from market centres either during marketing days organized once per week or month (famous as *gulio*) or from market centres such as Sanyajuu.

Locally saved seeds are obtained by visual sorting to obtain healthy seeds from his/her produce for use in next season but there is no separation between beans sale for seeds and beans sale for food in shops or market centers from market vendors. The finding is similar to Phiri (2006) that when formal system fail, farmers consider their own seed (farmer-saved) or that of their social network (farmer-traded) such as neighbours, friends and relatives, to be readily available, affordable and trusted compared to other seeds. Despite of some weakness, Wekundah (2012) documented informal seed system as a reliable and efficient way for farmers to access improved varieties of crops whose seeds attracted very limited interest of the commercial seed sector.

c) Semi formal seed delivery system

Bean seed delivery through semi formal system has been operating as supporter to disseminate new bean varieties or new generation introduced by research institutions such as SARI and SUA. Research institutions in collaboration with district council have been conducting Farmer field school (FFS) to demonstrate beans production. From FFS farmers obtain seeds for further multiplication. Furthermore, previously established community based bean seeds production in 1990s did not succeed to introduce effective semi formal seed delivery system due to lack of sustainability by the district council.

SUA-QDS project four years funded by COSTECH had been under implementation of sustainable semi formal bean seed delivery system through up scaling commercial small scale seed production and distribution through QDS scheme. Through SUA-QDS project in Siha trained 45 farmers on beans QDS production and about 250 farmers were involved in awareness campaigns in five wards of the district. Up to February 2013 SUA-QDS project supported QDS producers with basic seeds for the establishment of 5.2 ha (13 Acres) of beans QDS. Under SUA- QDS project four varieties of bean seeds were produced through QDS schemes (Table19).

Table 19: Beans QDS production in Siha district

Bean varieties	Basic seeds (Kg)	Ha of QDS
Lyamungu 85	240	3.2
Lyamungu 90	60	0.8
Rojo	60	0.8
Jeska	30	0.4
Total	390	5.2

Lyamungo 85, Lyamungo 90, and Jesca, and Rojo beans seeds varieties produced under QDS scheme in Siha were also among beans varieties demonstrated at Sanya Juu field day organized and executed in 2005 by bean Integrated Pest and Diseases Management

(IPDM) participating farmer groups in partnership with local authorities, extension services, research programmes and community service providers (SARI, 2005). However among these four varieties only Lyamungo 85 and Lyamungo 90 varieties were produced by surveyed farmers in Siha District in 2012.

4.2.4 Challenges facing beans QDS production

Land for seed production: Among the core challenge facing Siha trained QDS producers is land for QDS production but this study has found that QDS trained individuals have more access to land and allocate more land for bean production compared to untrained farmers (Table 20). However larger part of land for crop production was acquired by renting from either estate farms or large companies farms at cost ranging from 25 000 to 40 000 TSh per 0.25 ha (1 acres). For allocating 1 acre for QDS production of one bean variety 10m isolation from other bean variety from each side is required and 6m from any other crop is required. So for 40m x 100m or 4000 m^2 (1acre) for beans QDS a farmer requires 46m x 106m or 4876m^2 (1.219 acres) or must reduce 6m from each side of one acre (MAFC, 2001). Despite of having higher land owned per HH by bean QDS producers land shortages and high dependence on renting imposes challenges on commercial QDS production by small scale farmers in Siha District (Table 20).

Table 20: Land ownership and use in Siha district

Average of land	QDS producers	Other beans producers
Ha owned per HH	1.84	0.73
Ha rented in per HH	2.01	0.80
Total Ha under crop production per HH	3.50	1.52
Ha allocated for beans per HH	1.35	0.78
Percentage of hectares of beans per HH	38.57	51.32

Market preferences: Beans demand is variety specific therefore farmers tend to allocate more land for production for varieties with high price of output (Table 21). As it was documented in Hillocks *et al.* (2006) seed size, shape, colour and growth characteristics are main visible feature used by farmers in distinguishing bean varieties. Yellow beans *"soya njano"* followed by *Kariasee* and *Lyamungo* (Lyamungo 85 and 90) are the most grown bean variety and they are the ones with the highest market prices (Table 21). The finding is similar to Siha District beans production report (2012) that Yellow beans (soya njano); Kariasee and Rosekoko are the most produced bean varieties. However Lyamungo 85 and Lyamungo 90 have been renamed by bean producers to single name *Rosekoko* as a result of failure of farmers and traders to distinguish their features due to lack of labeling in bean trade and several years of seed recycling which has mixed bean varieties. Among beans QDS that was about to be supplied into the market in Siha district, only Lyamungo 85 and Lyamungo 90 were produced by the respondents which cause marketing challenge to QDS producers.

Table 21: Production of different bean varieties in Siha district

Variety	Hactre	Output (120Kg bags)	Output (Kg)	Output in Kg per ha	Range of price per bag of 120Kg
Soya njano	70.72	282.73	33 927.60	479.75	150 000-180 000
Lyamungo	7.30	29.50	3 540.00	484.93	120 000-180 000
Kariasee	11.00	30.46	3 655.20	332.29	120 000-180 000
Kibukoba	3.00	7.50	900.00	300.00	120 000-180 000
Kanada	2.80	1.84	220.80	78.86	80 000-110 000
Nganamna	1.20	0.42	50.40	42.00	120 000
Karanga ndogo	0.70	0.50	60.00	85.71	135 000

Competition from own saved seeds: Despite of being the most produced bean varieties; yellow bean varieties were not included in the QDS scheme because they were not improved and registered by TOSCI. The only varieties in QDS scheme which are among varieties grown by respondents are Lyamungo 85 and Lyamungo 90 (famous collectively as Rosekoko). Therefore analysis for characteristics of QDS demand in Siha analyzes demand for *Rosekoko* in this study (Table 22). Bean producers in Siha have their own seed mixtures of local varieties with a diverse gene pool. In general some of these meet their culinary needs whereas the demand for improved bean varieties is mainly for market (Hillocks, 2006).

Table 22: Seed demand and saving of different beans varieties

Variety	Seed quantity (Kg)	% of seeds by weight	Range of seed price per Kg	Seed saved for next season (Kg)
Soya njano	5 146	77.00	1 250-1 500	3 335
Lyamungo	588	8.75	1 000-1 250	460
Kariasee	640	9.53	1 000-1 500	336
Kibukoba	204	3.00	1 250-1 500	160
Kanada	108	1.60	900-1 000	120
Nganamna	24	0.35	1 000-1 200	160
Karanga ndogo	8	0.12	1 250	0
Total	**6 718**	**100.00**		**4 571**

It has been found that the price of each variety determines size of land to be allocated to its production and amount of seeds saved for sowing in the next season (Table 22). According to Hillocks, (2006), the requirement is the availability of varieties for which there is high market demand. So unless yellow bean varieties improved and included in QDS scheme or price of improved QDS varieties become superior, QDS are anticipated to face high competition from own saved seeds specifically from *yellow beans* which have the highest price among beans varieties produced in Siha District.

4.3 Factors Influencing Farmers Decision to Purchase of Maize QDS

A summary of results of the binary logit analysis is presented in Table 23 where dependent variable was whether farmer used QDS (coded 1) or not (coded 0). The overall test of likelihood of respondents to purchase QDS is based on the reduction in the likelihood values (123.61) for a model which does not contain any independent variables and the model that contains the independent variables (56.51). This difference in likelihood follows a chi-square distribution, and is the model chi-square (67.10).

Table 23: Determinants of farmers decision to purchase maize QDS

Predictors	Coefficients	Wald stat.	Sig. of Wald	Exp(B)
Gender (GN)	-0.747	0.442	0.506	0.474
Experience in maize production (years) (EXP)	0.040	0.946	0.331	1.040
Access to extension service (ES)	1.515	1.475	0.225	4.547
Membership in farmers association (MI)	3.032	5.738	0.017**	20.735
Access to credit (CR)	-2.750	3.191	0.074*	0.064
Access to NAIVS subsidy (SS)	3.066	3.381	0.066*	21.458
Previous use of QDS (RQC)	0.460	0.285	0.594	1.585
Use of Local varieties (LV)	1.172	1.535	0.215	3.229
Quantity of seeds from other farmer (QOF)	-0.146	4.966	0.026**	0.864
Quantity of own saved seeds used (QOS)	-0.065	9.510	0.002**	0.937
HH income from agriculture (IA)	0.000	4.576	0.032**	1.000
Number of maize varieties grown (VD)	3.808	8.729	0.003**	45.073
Ability to define varieties used (AD)	-18.975	0.000	0.999	0.000
Previous season maize price (Tsh) (PM)	0.000	0.663	0.415	1.000
Constant	-11.877	6.255	0.012	0.000

**Significance at $P \leq 0.05$, *Significance at $P \leq 0.1$, Initial -2 Log Likelihood = 123.613, -2 Log likelihood after adding predictors = 56.512, Nagelkerke R Square = 0.679, Chi-square=67.101, Model sig Chi square = 0.000, n=120.

This Chi square has 14 degrees of freedom and a probability of $p < 0.0001$, indicating that the model has a poor fit with the model containing only the constant and adding predictors have a significant effect on explaining the likelihood of respondents to use maize QDS and predictors forming a different model (Table 23). We therefore reject the null hypothesis that when QDS is accessible in rural seed market there is probability for all farmers to use QDS. The significance test for the model chi-square is our statistical evidence of the presence of likelihood of the dependent variable to be affected by the combination of the independent variables.

The Nagelkerke R^2 that ranges from 0 to 1 measures the strength of the relationship between predictor and dependent variable (Field, 2005). Nagelkerke's R^2 was 0.679, indicate a moderately strong relationship of 67.9% between the predictors and use of maize QDS (Table 23). This indicates that 67.9% of the variation in the likelihood of farmers to buy QDS is explained by logistic model.

Membership in farmer associations: The probability of the Wald statistic for the membership in farmers associations was 0.017, less than or equal to the level of significance of 0.05 (Table 23). The null hypothesis that the *B* coefficient for membership in farmers association was equal to zero was rejected. This provides the evidence that survey respondents who were members of farmers association were more likely to have used maize QDS. Membership in an association is an ordinal variable that is coded 1 for member and 0 for not member so that higher numeric values are associated with survey respondents who used QDS. The value of Exp (B) was greater than 1 (20.735) which implies that being a member of farmers association increased the odds that survey respondents used maize QDS. This finding is similar to Monge *et al.* (2008) found that membership in associations determines to a certain degree the use of improved technologies. This is because through associations farmers get access to information, inputs, infrastructure, and other supporting services.

Access to agricultural credit: The probability of the Wald statistic for the access to credit was 0.074, less than or equal to the level of significance of 0.1 (Table 23). The null hypothesis that the *B* coefficient for access to credit was equal to zero was rejected.

Access to credit is an ordinal variable coded 1 for farmers who had taken agricultural credit and 0 for those who have never taken credit so that higher numeric values are associated with survey respondents who used QDS.

The value of Exp (B) was less than 1 (0.064) which implies that accesses to agricultural credits decreased the odds that survey respondents used maize QDS. This means that purchase of Quality Declared Seeds by small scale farmers is not attached to any agricultural credit package therefore as farmers get an access to credit for purchasing seeds the probability of buying QDS decrease.

Farmers did not had opportunity to purchase QDS through agricultural credits because QDS is not recognized officially in credit packages or when farmers get credit do not purchase quality seeds through agricultural credits instead they tend to buy more expensive inputs and regard QDS as inferior to buy using credit. Similarly, Phiri (2006) found that distribution and purchase of quality seeds rarely backed by appropriate systems or schemes such as micro-credit, which could strengthen/support the purchasing power of smallholder farmers to enable the creation of commercial seed supply networks along more conventional lines.

Access to input subsidy: The probability of the Wald statistic for the access to subsidized seeds was 0.066, less than or equal to the level of significance of 0.1 (Table 23). The null hypothesis that the *B* coefficient for access to subsidy was equal to zero was rejected. This supports the relationship that survey respondents who had access to subsidized seeds were more likely to have used maize QDS. Access to subsidized seeds is an ordinal variable coded 1 for farmers who got subsidized seeds and 0 for those who did not get subsidized seeds so that higher numeric values are associated with survey respondents who obtained subsidized seeds. The value of Exp (B) was greater than 1 (21.46) which implies that accesses to agricultural subsidy increased the odds that survey respondents used maize QDS.

Input subsidies especially NAIVS programme have been an important policy instrument for promoting use of improved inputs including seeds in Tanzania (Masalawala, 2010). NAIVS has increased farmers experience with quality seeds and more OPV maize varieties. The quantity of seeds provided through NAIVS per farmer was limited to 10kg per household therefore as farmers find maize seeds to complement seed they obtained through NAIVS they find themselves in contact with lower priced QDS. So NAIVS has become an important tool for farmers to understand quality seeds and improved varieties thereby promoting them to buy QDS as the cheapest way to get quality seeds and desired improved maize varieties.

Quantity of seeds exchanged between farmers: The probability of the Wald statistic for quantity of seeds traded between farmers was 0.026, less than or equal to the level of significance of 0.05 (Table 23). The null hypothesis that the *B* coefficient for quantity of seeds bought from other farmers equal to zero was rejected. The value of Exp (B) was less than 1 (0.86) implying that an increase in quantity of seeds exchanged between farmers decreased the odds that survey respondents used maize QDS. Lack of an effective marketing scheme for QDS in rural areas has led to informal seed trade occurring between farmers which in turn affect negatively the use of QDS. This finding is similar to Minot *et al.* (2007) that as farmers rely on exchange of locally saved seeds the chance of using quality seeds decrease.

Quantity of own saved seeds used: The probability of the Wald statistic for quantity of seeds traded between farmers was 0.002, less than or equal to the level of significance of 0.05 (Table 23). The null hypothesis that the *B* coefficient for quantity of own saved seeds used by farmer equal to zero was rejected. The value of Exp (B) was less than 1 (0.94) implying that an increase in quantity of own saved seeds decreased the odds that survey respondents used maize QDS. This finding is similar to previous findings that farmers continue to recycle seed over a long period of time and only occasionally demand new seed from outside to replace their seed in most cases (Olatokun *et al.*, 2010; Graudal and Lilleso, 2007, Minot *et al.*, 2007). Therefore, dependence of farmers on own saved seeds decrease the use of QDS. Lack of marketing strategies for QDS has led into export of QDS to the outside boundary of a ward where they are produced. Limited number of customers of QDS has led QDS producers to rely much on the market outside their ward because no reliable local markets demand for QDS within single ward.

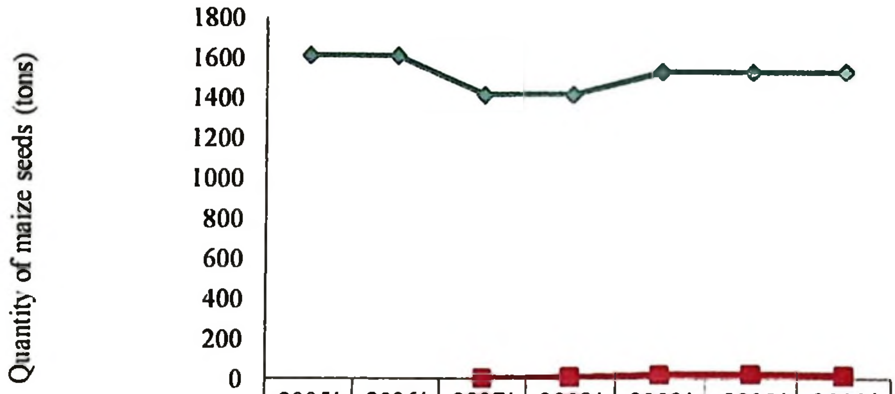
Household income from Agricultural activities: The probability of the Wald statistic for household income from agriculture was 0.032, less than or equal to the level of significance of 0.05. This gives an evidence to reject the null hypothesis that the *B* coefficient for household agricultural income equal to zero. The value of Exp (B) was 1 implying that an increase in household income increased the odds that survey respondents used maize QDS. This finding is similar to that of Minot (2008) and Kugbei and Shahab (2007) which showed that limited income from the sale of agricultural produce limit farmers from purchasing quality seeds.

Number of maize varieties: The probability of the Wald statistic for the number of varieties grown by the farmer was 0.003, less than or equal to the level of significance of 0.05 (Table 23). The null hypothesis that the *B* coefficient for number of maize varieties grown by farmer was equal to zero was rejected. The value of Exp (B) was greater than 1 (45.06) implying that as number of maize varieties grown by farmer was higher, the odds that survey respondents used maize QDS increased. Demand for more improved varieties of maize promotes the purchasing of QDS. However, farmers often do not know or understand varieties as the result farmers keep on growing many varieties at one time (Minot *et al.*, 2007). Similarly, this study has found that as farmers keep on growing more than one variety at one time the probability of farmers to buy QDS increase. This is due to farmers wanting to try growing different varieties as coping strategy for overcoming weather uncertainties of rain fed agriculture and maximizing production from varieties which will be adopted to climate and produce more. This is an indication of lack of weather information prior to starting of production and poor understanding of the varieties.

4.4 Demand for Quality Declared Seeds

4.4.1 Demand for maize QDS

Statistics showed that hectres of maize in Kongwa District decreased from 64 412 Ha in 2006 to 61 4829 in 2009 (Table 7). Decrease in hectares of maize was because of draught and farmers allocated their land to more draught resistant crops. It was found that at seed rate of 25 Kg per ha recommended to farmers in Kongwa District the demand for seed in the district was 1 540 tons at the period of this study. Statistics shows that despite of decrease of demand for maize seeds from about 1 611 tons in 2005/07 to about 1 540 tons in 2011/12 season, there have been rise and fall in seed demand due to differences in weather condition between years in the district (Fig.7).



Years	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12
Seed demand (tons)	1611	1611	1420	1421	1537	1537	1540
Maize QDS supply (tons)			3	10	21	23	17

Figure 7: Trend of maize seed demand and QDS supply in Kongwa district

The supply of maize QDS grew from 3 tons in 2007 tons to 17 tons in 2010 with some rise and fall as in the case of seed demand. However, the supply of maize QDS is far below QDS supply in the district (Fig. 7). On other hand, the demand of maize QDS in the district varies across HH. It is therefore important to understand maize QDS market by studying behaviour of seed customers. Linearized Cobb Douglass model was therefore used to estimate demand for QDS varies across HH. OLS regression result shows that the coefficient of determination (R^2) of our model is 57.2% and F statistic is significant at $P \leq 0.001$ (Table 24). The null hypothesis that farmers with different characteristics have similar demand for QDS is therefore rejected. The significance of R^2 suggests that 57.2% variation in natural log of quantity of maize QDS purchased by HH is explained by specified model. About 42.8% of such variation is explained by error term. The specified model is therefore moderately strong to explain demand for maize QDS in Kongwa. Furthermore, muticollinearity which is common in most of cross sectional data was also not a serious problem as VIF for all predictors were less than 10 (Table 24).

Table 24: Regression estimates of maize QDS demand

Variables	B	t-statistic	Sig	VIF
Constant	4.030	3.702	0.000	
Natural log of HH maize seed expenditure (E_s).	0.500	10.592	0.000	1.138
Natural log of price of recycled seeds (P_M).	-0.965	-5.434	0.000	1.116
Use of own saved seeds (D_o).	-0.441	-4.881	0.000	1.329
Respondent gender, G1 (Female) (D_G).	0.287	3.608	0.000	1.140
Number of crops grown by household (N_c).	-0.091	-2.255	0.026	1.102
Off farm income (D_E).	0.204	2.517	0.013	1.066
Use of recycled QDS (R_{RQDS}).	0.182	2.289	0.024	1.110

R^2=57.2, F statistic $_{(6, 21)}$ = 18.53, n=23, Sig of F stat. =0.000, Dependent variable: Natural logarithm of quantity of QDS purchased by farmer, *significant at P≤0.001, **significant at ≤0.05.

Equation 13 present literalized Cobb Douglass equation from OLS regression output (Table 24) which if other things remain constant can be used to estimate individual household demand for maize QDS in Kongwa District.

$$\ln q = 4.030 + 0.5\, ln\, E_s - 0.965 lnP_m - 0.091N_c - 0.441D_o + 0.287D_G + 0.204D_E + 0.182D_{RQDS} \quad \text{.......(13)}$$

Under ceteris paribus this model (Equation 13) can be used to estimate demand of maize QDS when farmer seed expenditure, price local seed, gender and income sources, behaviour of using own-saved seeds and whether farmer recycle of QDS are known. However, this estimate varies across households with different characteristics in relation to demand for maize QDS as explained more in next paragraphs.

Intercept coefficient: The intercept of the regression equation 13 (4.030) is positive and significant at P≤0. 0001 (Table 24). When base of natural logarithm is introduced to intercept of the equation we get 56.26. This means that when other things remain constant, intercept base of natural log refers to quantity of maize QDS that would be demanded by HH if no effects of variables in specified model (Equation 13).

Expenditure elasticity: The slope coefficient for expenditure on seed reflect expenditure elasticity of demand for maize QDS. The coefficient is 0.5 and is significant at P<0.001 (Table 24). We therefore had strong evidence to reject the null hypothesis that the expenditure elasticity of maize QDS equals to zero. According to Sadoulet and De Janvry (1995) if value of e_c fall between 0 and 1, indicating that the commodity was a necessity among a group of commodities which share the same budget. Maize QDS have been regarded as necessary seed among other sources of seeds when different HH allocate budget for maize seeds. The necessity maize QDS for maize producers in Kongwa arise because HH with higher seed budget bought more maize QDS compared to households with lower maize seed expenditure (Figure 8).

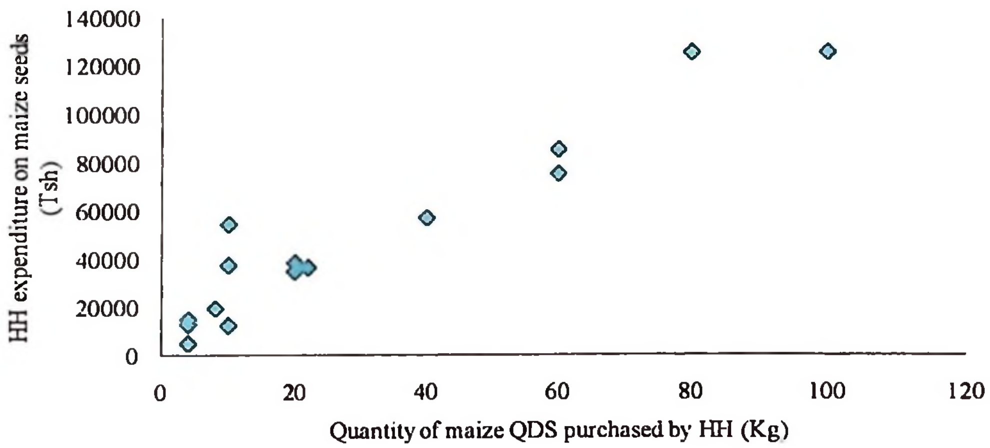


Figure 8: Maize QDS purchase by households with different maize seed expenditure

Differences in the purchase of maize QDS between HH was due to differences in seed expenditures across HH. Quantity of maize QDS used by HH was higher for households which spent more on maize seeds (Figure 8). Most of the maize seeds expenditure (63%) was used for purchasing maize QDS (Table 25) despite the largest proportion of maize seeds were obtained from recycled seeds saved locally. Expenditure on subsidized seeds constituted 30% of household seed expenditure and was similar throughout all surveyed households because all HH spent 10 000Tsh for 10Kg of subsidized maize seeds.

Table 25: Expenditure on maize seeds

Seed expenditure	Expenditure (Tsh)	Budget share (%)
Total expenditure on subsidized seeds	660 000	30
Total expenditure on QDS	1 380 000	63
Total expenditure on recycled seeds	151 000	7
Total seed expenditure	2 091 000	100

Cross price elasticity: The slope coefficient for the price of seeds bought from another farmer (Equation 13) reflect cross price elasticity of demand for maize QDS. Such coefficient is -0.965 and is significant at P<0.001 (Table 24). We therefore had strong evidence to reject the null hypothesis that cross price elasticity of maize QDS versus locally distributed equals to zero. The value of cross price elasticity less than zero indicates that an explained commodity was complement where otherwise (e_{ij} > 0) the commodity would be substitute. Therefore maize QDS are complement to maize seeds obtained through informal seed system (in this case maize seeds exchanged between farmers or opportunity cost of using stored maize as seeds). This means that maize QDS was used in combination with locally saved seeds across farmers in such a way that QDS adds value to locally saved seeds.

The negative coefficient means that when opportunity costs or price of locally recycled seeds was higher farmers demand for maize QDS was lower. Usually, farmers search for locally seeds which performed better in last season for use in next season; as a result farmers with seeds which performed better gave more value to their seeds and sold such seeds at higher price to their fellow farmers. Here we can conclude that seeds traded through informal market have grades from which price are set based on the quality. Experience from Minot *et al.* (2007) shows that when buying seed, farmers can only inspect for physical impurities but it is not possible to know the genetic potential therefore farmers may pay a premium for high-quality seed without being sure that the quality is actually higher.

Maize QDS is used as high quality seeds together with locally-recycled seeds in a way that QDS formed basic seeds for multiplying seeds as strategy to obtain minimize costs of seeds and obtaining more improved seeds at lower costs in next season. This finding is similar to Minot *et al.* (2007) and Olatokun *et al.* (2010) that farmers seeds demand from outside is only for replacing seeds recycled for a long period of time. In such context farmers tend to buy maize QDS for own seed multiplication for obtaining seeds for use in the next seasons. Since OPV varieties may preserve their genetic purity up to some years, having QDS in a farm add value to recycled (low valued seeds) seeds.

Crop diversification: The slope coefficient for a number of crops grown by farmers (B_N) is -0.091 and significant at $P<0.001$ (Table 24). We therefore had strong evidence to reject our null hypothesis that the slope coefficient for a number of crops grown by HH equals to zero.

Negative coefficient means that there was decrease in proportional difference in QDS purchased across households for additional crop grown by HH. This means that the variation in QDS purchase among HH diminished for HH which grow many crops. This is an indication of competition for household resources between crops. As number of crops increase the proportion of household resources allocated to maize decrease as the result farmers opts for cheap inputs available. In doing so farmers find themselves decreasing proportion of QDS in the household maize seed package as they increase the number of crops. Nationwide, maize has been the priority crop of choice for an overwhelming majority of households across seasons in which other crops are grown together (URT, 2012). In Kongwa one household grew between 3 to 7 crops per season.

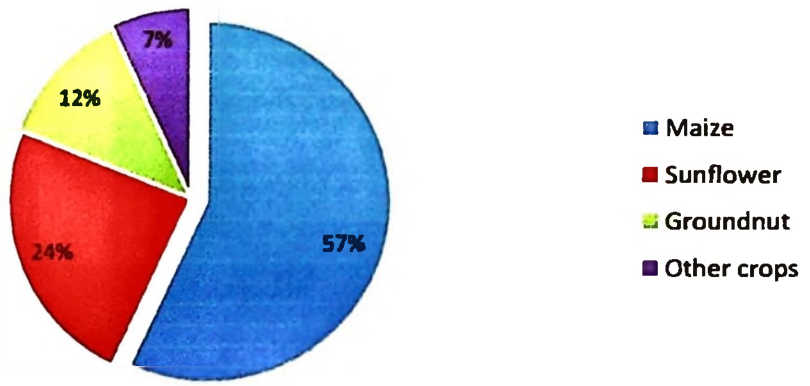


Figure 9: Land allocation to different crops in 2011/12 season

Maize led as the most grown crop in terms of percentage of land allocated for its production (57%) followed by sunflower and groundnuts follow in order by 24% and 12% whereby other crops such as sugar cane, sweet potato, rice, cassava, pigeon pea, sesame, sorghum, finger millet and yams are grown on remaining 7% of land (Fig. 9). This finding shows that the extent of use of QDS by HH is limited by lack of crop specialization because as the farmer increase diversification, the proportion of HH resources allocated to maize decrease. Farmers tend to diversify their farming as a strategy to overcome shocks of climate change and increasing their return from farming activities. Similarly WB (2005) has documented growing of various kinds of crops as a risk coping strategy to overcome livelihood shocks due to climate changes. Therefore crop diversification has a negative effect on maize QDS demand.

Use of own saved maize seeds: Dummy for use of own saved seeds variable categorized as not used own seeds (0) and use of own saved seeds (1). Its slope coefficient is - 0.441 and significant at P<0.001 (Table 24). The null hypothesis that the slope coefficient for use of own saved seeds equals to zero is therefore rejected. The negative coefficient means that when other things remains constant, there was diminish in maize QDS purchase for farmers who used own saved seeds compared to those who did not use own saved seeds. Interactions of dummy for use of own saved seeds with intercept and slope coefficient has led to change in coefficients in Equation 13 resulting into Equation 14.

$$\ln Q_{QDS} = 3.589 + 0.059\ln C_s - 1.406\ln P_m - 0.091N_c + 0.287D_G + 0.204D_E + 0.182D_R \text{..........(14)}$$

With reference to equation 14 to account for effect of use of own saved seeds after interactions, when other things remain constant;

- Farmers who used own saved seeds purchased lower quantity of maize QDS compared to farmers who did not use own-saved seeds (intercept decrease).
- Use of own saved seeds led to lower maize QDS expenditure elasticity compared to farmers who did not use own saved seeds but did not alter maize QDS.
- Use of own saved seeds led to lower cross price elasticity between maize QDS and farmer saved seeds compared to when HH did not use own saved seeds.

The use of own saved seeds has been found to have a negative effect on household purchase of maize QDS. The finding is similar to Katungi *et al.* (2011) and Minot *et al.*, (2007) which documented the use of own saved seeds as among the reason for low demand and then purchases for quality seeds.

Gender: Gender of household decision maker in maize production was categorized as a woman (1) and men (0). The coefficient for gender 1 is 0.287 and this value is positive and significant at P<0.001 (Table 24). There is strong evidence to reject the null hypothesis that the slope coefficient for gender equals to zero. Positive coefficient means that when other things remained constant, for HH with a woman as ultimate maize production decision maker there was additional maize QDS purchased compared to HH where men were ultimate decision maker on maize production. Interactions of dummy for gender with intercept and slope coefficients led to change in coefficients in equation 13 and resulted in equation 15.

$$\ln q = 4.317 + 0.787 \ln C_s - 0.678 \ln P_m - 0.091 N_c - 0.441 D_o + 0.204 D_E + 0.182 D_R \quad \text{.......} (15)$$

When other things remain constant changes the following are findings are the effects of gender in relation to household maize QDS demand;

- Female maize producers purchased more maize QDS compared to male maize producers (increase in the intercept).
- Maize QDS expenditure elasticity was higher when maize producer was female compared to male maize producers.
- Cross price elasticity was higher when maize producer was female compared to when were male.

According to FAO (2010) production technologies unfamiliar to smallholders and not compatible with other parts of the production system are risky and women become more disadvantaged once they adopt. Therefore the finding in this study proves maize QDS use to be compatible with the local farming system beneficial to women in Kongwa.

Off farm income: Having an alternative source of income was categorized as not having off farm source of income (0) and having off farm source of income (1). Its slope coefficient is 0.204 and significant at $P<0.05$ (Table 24). We therefore had strong evidence to reject the null hypothesis that the slope coefficient for HH having off farm income equals to zero. Positive coefficient means that if other things remain constant, HH having off farm sources of income was able to purchase additional maize QDS compared to farmers who depend on farm incomes only. Interactions of dummy for gender with intercept and slope coefficient has led to change from equation 13 to Equation 16.

$$\ln Q_{QDS} = 4.234 + 0.704\ln C_s - 0.761\ \ln P_m - 0.091 N_c - 0.441 D_o + 0.287 D_G + 0.182 D_R \quad \text{..........(16)}$$

When other things remain constant, accounting for effects of off farm income sources on maize QDS demand are as follows;

- Maize producers with off farm sources of income purchased more maize QDS compared to farmers who did not have off farm source of income (increase in the intercept).
- Maize QDS expenditure elasticity was higher for maize producers with off farm sources of income compared to maize producers who did not have off farm of income.
- Cross price elasticity was higher for maize producer with off farm income compared to farmer with no off farm source of income.

This finding is similar to Minot Minot *et al.* (2007) that off farm sources of income promote farmers purchase of quality seeds and other inputs (Minot *et al.*, 2007). According to SUA (2007) off farm activities is among livelihood strategy used by farmers for overcoming weather uncertainties associated with rain fed agriculture.

Recycling of maize QDS: Recycling of QDS variable was categorized as use of recycled maize QDS (1) and never used recycled QDS (1). Its slope coefficient is 0.182 and significant at P<0.05 (Table 24). Therefore there is strong evidence to reject the null hypothesis that the slope coefficient for use of recycled QDS equals to zero. Positive coefficient means that when other things remains constant, use of recycled QDS seeds had the additional effect to maize QDS purchase by comparing to farmers who did not use recycled seeds originated from QDS. Interactions of dummy for gender with intercept and slope coefficient has led to change in coefficients of equation 13 to Equation 17.

$$\ln Q_{QDS} = 4.212 + 0.682 \ln C_s - 0.783 \ln P_m - 0.091 N_c - 0.441 D_o + 0.287 D_G + 0.204 D_E \quad \text{.......} (17)$$

When other things remain constant, accounting for effects of the use of recycled maize QDS seed interactions have following outcomes of maize QDS demand;

- Farmers who used recycled QDS purchased more maize QDS compared to farmers who had never used QDS (increase in the intercept).
- Maize QDS expenditure elasticity was higher for maize producer who used recycled maize QDS compared to those who did not use recycled maize.
- Cross price elasticity was higher when maize producer used recycled maize QDS compared to those who did not use recycled QDS.

This finding is similar to Doss *et al.* (2003) that farmers experience with the seeds determines their purchasing behaviour. Furthermore, Kugbei and Shahab (2007) explained that it is expected that farmers buying new quality seed will continue to multiply this seed for some years before renewing it. Therefore maize QDS are purchased and used together with recycled seeds originated as a seed acquisition strategy for further multiplication for next season use.

4.4.2 Demand for improved bean varieties under QDS scheme

Hectre of beans in Siha District increased from 5 563 Ha in 2007 to 9 391 in 2009 (Table 8) and that indicate an increase in seed demand in the district. Seed rate of 75 Kg per ha has been recommended to farmers in Siha District for most of bean varieties produced in the district. Therefore the demand for bean seed in Siha District increased from about 417 tons in 2007/08 to about 704 tons in 2011/12 season (Fig. 10). The growth in demand for seeds is associated with an increase in allocation of more land to beans due to increase of demand for beans in the district.

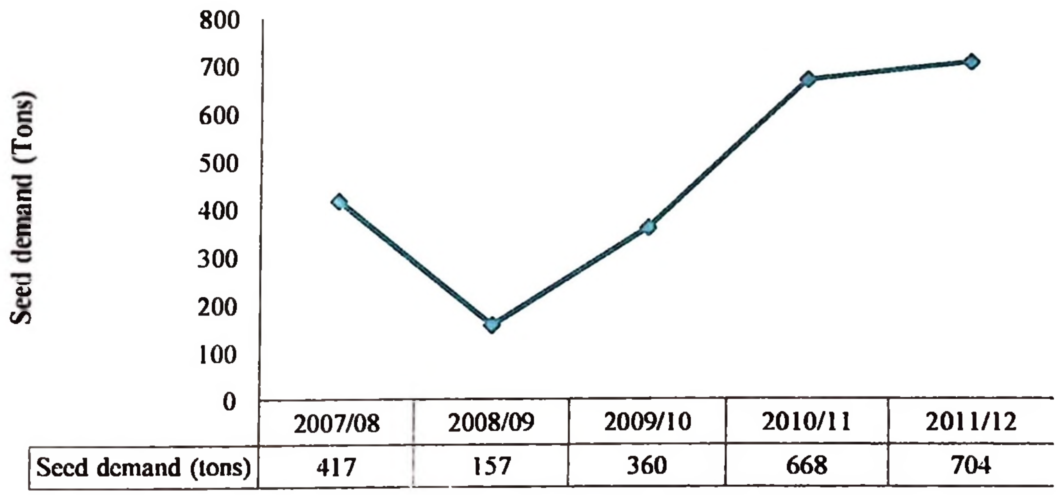


Figure 10: Trend of bean seed demand in Siha district

Table 22 shows that the demand for bean seed of different varieties varies in the district. It is therefore important to understand behaviour of demand for bean seeds of improved varieties produced through QDS scheme in order to understand behaviour of bean QDS customers. Among beans QDS produced in Siha only Lyamungo 85 and Lyamungo 90 were beans varieties produced by randomly selected respondents of this study. Other varieties were rojo and Jesca which none of respondents produced them. However this section considers Lyamungo 85 and 90 as single variety due to fact that farmers and traders were not able to distinguish them and identified them as single variety "*Lyamungo or Rosekoko or farm*". Lyamungo 85 and Lyamungo 90 have been mixed during production and in the market were sold at the same price and therefore not distinguished by farmers and traders in the market due to their similarities in colour (Fig.11).

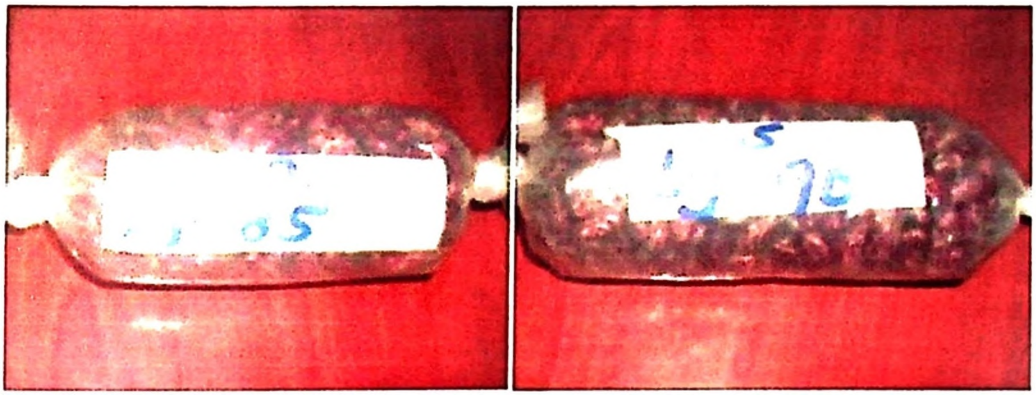


Figure 11: Lyamungo 85 and Lyamungo 90 bean varieties

Coefficient of determination (R^2) was 74% and F statistic is significant at $P \leq 0.001$ after regression analysis. We therefore have strong evidence to reject our null hypothesis that farmers with different characteristics have similar demand for bean seeds of varieties produced through QDS scheme. The significance of R^2 suggests that 74% variation in natural log of quantity of *Rosekoko* seeds used by HH is explained by specified model. About 36% of such variation is explained by error term. The specified model is therefore moderately strong to explain the demand for seeds of bean varieties produced through QDS scheme. Therefore, muticollinearity was not a problem as VIF for all predictors were less than 10 (Table 26).

Table 26: Regression estimates of demand for bean seeds of varieties in QDS scheme

Predictors	B	t-statistic	Sig.	VIF
(Constant)	-18.275	-5.189	0.000	
Natural log of price of purchased seeds; P_L	2.761	4.942	0.000	1.078
HH bean varieties diversity; VD	-0.082	4.242	0.000	1.059
Obtained seeds from other farmer; D_o	0.115	-3.780	0.000	1.097
Access to extension service, D_{EX}	0.064	-2.748	0.002	1.024
Bought seeds from nearby shop; D_{SS}	0.139	-2.336	0.018	1.077

Dependent variable: Natural log of quantity of Rosekoko bought by HH, R^2=0.74, F statistic (4, 35) = 64.90, n=37, Significance of t statistic = 0.000.

Equation 24 present equation from which if other things remain constant can be used to estimate households demand for seed demand of bean varieties under QDS seed scheme.

$$\ln q_L = -18.275 + 2.761\ln P_L - 0.082V_D + 0.115D_{OF} + 0.064D_{EX} + 0.139D_{SS} \text{ .... } (18)$$

Demand estimate varies across households with different characteristics in relation to access of seeds of variety under estimation as explained more in next paragraphs.

Intercept: Intercept of equation 18 (-18.275) is negative, introducing base of natural logarithm we get 1.156×10^{-8} which refers to quantity of Lyamungo 85 and Lyamungo 90 production in the absence of other variables. When other things remain constant, intercept coefficients is approximately 0.000 after introducing base of natural logarithm indicating that in the absence of any predictors in the model there would be no significant demand for seeds such varieties would be demanded by farmers.

Own price elasticity of seeds: The slope coefficient for natural log of Lyamungo seed price was 2.761 and significant at $P \leq 0.0001$ (Table 26). We therefore have strong evidence to reject the null hypothesis that own price elasticity for *Lyamungo* bean seeds equals to zero. If $e_{ii}>1$ the commodity is elastic, if $e_{ii}<1$ the commodity is inelastic and if $e_{ii}=1$ it is unitary elastic (Sadoulet and De Janvry, 1995; Greene, 2002). Therefore

Lyamungo 90 and Lyamungo 90 bean seeds demand was elastic in Siha district seed market. This means that a small difference in price of seeds or opportunity cost of using bean as seeds led to higher difference in quantity of Lyamungo seeds used across household in Siha district. Furthermore the own price elasticity was positive indicating that the cross sectional demand curve for Lyamungo 85 and Lyamungo 90 was positively sloped across surveyed households (Fig. 12).

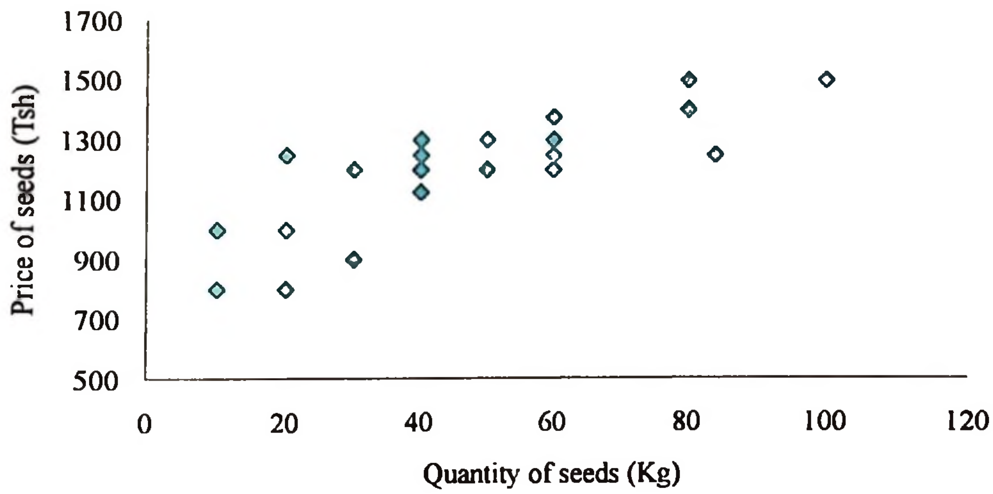


Figure 12 HH demand for beans seeds at different bean prices

Positive own-price elasticity implies that consumers purchased a greater quantity as the price increases (Eisenhauer and Principe, 2009). Prices of beans in this study were based on response to different bean prices at which different producers bought seeds from different sources and opportunity costs of using beans as seeds instead of selling them. Therefore the demand for *Lyamungo* (Lyamungo 85 and Lyamungo 90) beans seeds increased as prices were found higher by household. Bean seeds have been bought from local (informal) sources of seeds where beans produce is also traded. The finding is an indication that household beans seeds demand for a particular variety increases as household have information on higher price before they buy and plant bean seeds. Furthermore it is an indication that households had variation in access to price information produced more bean of a variety. Tripp and Rohrbach (2001) document such situation as limit to small scale seed producers who may be unable to set a price which recover their full costs if they will try to have price competition with informal seed sources.

Bean varieties diversity: Number of bean varieties grown by HH in a season (V_D) coefficient is -0.082 and significant at $P \leq 0.0001$ (Table 26). We therefore have strong evidence to reject the null hypothesis that the slope coefficient for bean varieties diversity equals to zero. Negative sign indicates that under ceteris paribus there was a proportional decrease quantity of Lyamungo 85 and Lyamungo 90 beans seed demand across HH for every one additional bean variety grown by household. As the number of varieties of bean seeds grown by HH increased there was a decrease in proportion of Lyamungo bean seeds demanded across households.

According to Minot *et al.* (2007) farmers often do not know or understand varieties as the result farmers keep on growing many varieties at one time. Farmers have been growing more than one variety of beans as a diversification strategy to overcome marketing and risks associated with lack of farmers control of bean prices. As a result, as farmer growing many varieties of beans creates competition for household bean production resources between varieties occur and reduce demand for seeds of a particular variety.

Seed trade between farmers: The coefficient for dummy for use of seeds bought from another farmer is 0.115 and significant at $P \leq 0.0001$ (Table 26). We therefore had strong evidence to reject the null hypothesis that the slope coefficient for use of bean seeds traded between farmers equals to zero. When other things remain constant, positive coefficient means that seed trade between farmers had an additional effect on Lyamungo 85 and 90 seeds. Interactions of dummy for use of bean seeds obtained from other farmers with intercept and slope coefficients changes equation 18 to equation 19.

$\ln q_L = -18.160 + 2.876 \, ln \, P_L - 0.082 \, B_D + 0.064 D_{EX} + 0.139 D_{SS}$ ....(19)

With reference to equation 19 which account for effects of use of bean seeds obtained from other farmers, when other things remain constant there were following outcome on households such seeds demand;

- When beans producer obtained seeds from other farmers there was additional use of Lyamungo bean seeds compared to when farmers did not obtain seeds from other farmers (increase in intercept coefficient).
- Use of seeds obtained from another farmer increased an own price elasticity coefficient of Lyamungo bean seeds. An increase in an elasticity shows that Lyamungo beans seeds become more elastic as farmers get an excess of seeds from neighbour farmers compare to those who didn't obtain seeds from other farmers.

This study has revealed that seed trade between farmers helps to promote more purchase of more seeds of improved varieties. This finding is similar to experience of Africa's seed systems documented in AGRA (2010) that the main source of information on the best varieties to grow was from other farmers. In addition, lack of formal source of seeds promotes farmers to find seeds from other farmers who they exchange information.

Access to extension service: The coefficient for dummy for contact with extension services during bean production season is 0.064 and t-statistic is significant at $P \leq 0.005$ (Table 26). We therefore had evidence to reject the null hypothesis that the slope coefficient for access to extension service equals to zero. When other things remain constant, positive coefficient means that access to extend service had an additional effect on Lyamungo beans seeds demand. Interactions of dummy for access to extension service with intercept and slope coefficient has led to change of coefficients in equation 18 to equation 20.

$\ln q_L = -18.275 + 2.825\, ln\, P_L - 0.082 B_{VD} + 0.115 D_{OF} + 0.139 D_{SS}$ --------- (20)

Accounting for effects of extension service, when other things remain constant followings are outcomes on household Lyamungo bean seeds demand;

- There was additional demand for Lyamungo 85 and 90 bean seeds for farmers who had contact with extension service in a season compared to farmers who did not have contact with extension service, as indicated by increase in equation intercept.
- Own price elasticity of Lyamungo 85 and 90 bean seeds was higher for farmers with contact to extension service compared to those who did not have contact with extension service in a season.

Despite of lack of formal supply of beans seeds extension agents in Siha have been recommending farmers to produce Lyamungo 85 and Lyamungo 90 beans (collectively as Rosekoko) because were the only improved bean varieties available with a high price in the market. As a result, access to extension service has positive influence on demand for Lyamungo 85 and 90 beans seeds. Similarly, Hillocks (2006) documented that extension service has an important role in influencing the use of bean varieties as it has been found in this study.

Seeds purchase from a nearby shop: The coefficient for dummy for buying seed is 0.139 and its t-statistic is significant at $P \leq 0.05$ (Table 27). We therefore had evidence to reject the null hypothesis that the slope coefficient for access to bean seeds from a nearby shop equals to zero. When other things remain constant positive coefficient means that access to seeds from nearby shop had an additional effect on Lyamungo beans seeds demand. Interactions of dummy for use of bean seeds from nearby shops with intercept and slope coefficient changed equation 18 to equation 21.

$$\ln q_L = -18.136 + 2.90\, ln\, P_L - 0.082\, B_{VD} + 0.115 D_{OF} + 0.064 D_{EX} \text{ ------------- } (21)$$

Accounting for effects of access of seeds from nearby shop, when other things remain constant, the followings are outcomes on Lyamungo seeds demand;

- There was additional use of Lyamungo bean seeds for farmers who bought bean seeds from nearby shops compared to those who did not purchase seeds from nearby shops.
- Own price elasticity for Lyamungo bean seeds was higher for farmers who bought seeds from nearby shops compared to farmers who did not buy seeds from nearby shops. An increase in an elasticity shows that Lyamungo beans seeds become more elastic as farmers get an access of seeds from nearby shop.

The findings in this study show that shops nearby bean producers play an important part in distribution of bean seeds. Similarly, Sentimela and Kosina (2006); Granqvst (2009) and MAFC (2001) documented that seed supply nearby to farmers promote the use of improved seeds thereby removing distance barriers for farmers to access speeds. Nearby shops as local suppliers has greater knowledge of their customers needs and may be more flexible in meeting their requirements (Batt, 2000b). Since Lyamungo 85 and Lyamungo 85 QDS are produced in local areas, local shops and input suppliers are important in promoting and distributing beans QDS for varieties produced through QDS scheme in the Siha District.

4.4.3 Policy framework of rural seed market with QDS

According to MAFC (2012) seed status report QDS supply in seed market is still low to meet demand of seeds for maize and bean farmers. This study has found that rural seed markets has three sources of OPV maize seeds (farmer saved seeds, certified seeds and QDS), all of which in equilibrium (Fig. 13). Price of QDS (P_{QDS}) in the market is higher than price of farmer saved seeds (P_{FS}) and subsidized certified seeds (P_{SCS}). NAIVS input voucher scheme for promoting the use of quality inputs includes certified seeds only and therefore lower prices and increase supply of certified seeds and hence increase use of quality seeds in rural areas. This is denoted by the shift of certified seeds supply curve from S_{CS} to S_{SCS} and the change in demand for certified seeds from Q_{CS} to Q_{SCS} (Fig. 13).

Subsidy programmes such as NAIVS have increased supply and use of quality seeds. Seed demand for certified seeds through NAIVS is perfectly elastic since seed market forces (demand and supply) cannot alter price of NAIVS seeds. It is however uncertain whether farmers demand for certified seeds will remain higher after the end of the NAIVS subsidy programme. It have been revealed that experience of obtaining subsidized certified seeds at lower price and late distribution of inputs by NAIVS agents makes subsidy programmes not sustainable and reliable way for securing quality seeds access for small scale farmers through market operations.

According to Granqvst (2009) QDS scheme was formed as a way to fill a gap between system formal and informal seed system. It has been found in this study that QDS are quality seeds and were sold at a lower price than certified seeds. Based on a graphical illustration of partial equilibrium market of seed in Fig. 13; Q_{QDS} is the quantity of QDS bought at price P_{QDS}. This price is lower than the market price of certified seeds (P_{CS}) but higher than the price of subsidized certified seeds (P_{SCS}). QDS cannot compete with subsidized certified seeds because of its higher price than subsidized seeds. for QDS to compete with certified seed there are two options either subsidizing QDS to price equal to subsidized certified seeds (using QDS in NAIVS package) or QDS producers have to sell QDS at a price equal to price of subsidized certified seeds (P_{SCS}).

Even if there would be subsidy support in place, QDS still face strong competition from own saved seeds which are either closely available to farmers through own saving (opportunity cost of selling maize), through barter trade or at a price equal to the maize price (P_{FS}). For any rural quality seed supplier such as QDS producers to increase competition with farmer saved seeds, price must be lowered to near equal or equal to farmer saved maize price, however it is difficult due to high costs of seed production. For example at Kongwa local maize seeds were sold at maximum price of 400 Tsh per Kg while subsidized OPV maize seeds were sold at 1000 Tsh per Kg, 1Kg of OPV maize QDS were sold at an average price of 1250 Tsh per Kg (sold in package of 2Kgs at 2500 Tsh) and unsubsidized OPV maize seeds were sold at 2000 Tsh per Kg (sold in package of 2Kgs at 4000 Tsh). It is therefore clear that OPV maize QDS can only compete with unsubsidized certified seeds in rural seeds market.

QDS scheme which is designed to make best use of limited technical resources in the seed system but QDS marketing is restricted to be within a ward; therefore this partial equilibrium market framework also assumes seed market within a ward. Despite of use of NAIVS and QDS scheme the demand of seeds from locally saved seeds is still high because the price of farmer saved seeds is still lower than subsidized seeds and QDS. However the use of own saved seeds should not be a threat to QDS market because even developed countries such as USA there is seed recycling (Minot *et al.*, 2007).

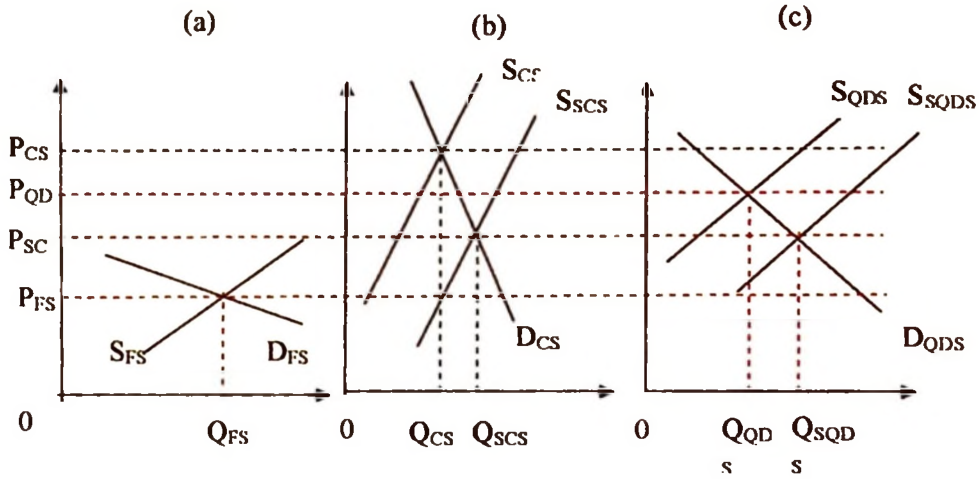


Figure 13: Hypothetical partial equilibrium analysis of rural seed market with QDS

4.5 Summary

4.5.1 Maize seeds systems and market

a) Maize seed systems

Maize QDS has become an important maize seed supply scheme in Kongwa District. However the performance of delivery systems shows that dependence on farmer saved seeds is still very high (76%) compared to sources of quality seeds (25). Despite lower use of quality seeds the share of maize QDS by weight is higher (15%) compared to NAIVS and input stores (9%). Most of farmers depend on NAIVS subsidized seeds for obtaining quality seeds despite of limited quantity of 10 Kg supplied per farmer. High dependence on informal system is attributed by recycling of OPV maize seeds, higher prices of QDS and certified seed, lack of input suppliers in rural areas, high demand for maize QDS to area outside legal boundary of single ward which cause shortage of maize QDS within legal market and weather uncertainty which affect both QDS production and maize production as whole.

b) Factors influenced the likelihood of household to purchase maize QDS

Membership to farmers association; access to credit; access to input subsidy through NAIVS; Quantity of seeds obtained through informal seed trade between farmers; Quantity of own saved seeds used; Household Income from Agricultural activities and number of varieties demanded by farmer among factors that have been found to influence QDS purchase in Kongwa.

Association membership: Membership to farmers associations increase probability of farmer to purchase maize QDS due to the important role of such institutions in knowledge and information dissemination.

Agricultural credit: Access to agricultural credit has not yet benefited maize QDS users because no any credit scheme directly related to QDS purchase therefore access to credit diminished probability of farmer to purchase QDS.

Subsidized seeds: Despite of competition from certified seeds distributed through NAIVS scheme, use of subsidized maize seeds has increased farmers contact with quality seeds thereafter increased probability of farmers to purchase maize QDS to supplement certified seeds supplied through NAIVS subsidy. High use of own-saved seeds and seeds obtained from informal seed trade (seed exchange) between farmers decreased probability of farmer to use maize QDS because such seeds are cheaper compared to QDS.

HH maize varieties diversity: Number of maize varieties grown by farmers increased farmers probability to purchased of maize QDS. Many varieties grown per HH is an indication of farmers trial to overcome weather uncertainty.

Income from farm: Household with higher agricultural income had higher probability of purchasing maize QDS because of high purchasing power.

c) Demand for maize QDS

The demand for maize seeds in Kongwa District was estimated to be about 1540 tons while maize QDS supply was about 16. 57 tons in 2011/12 which if far below maize seed maize demand. In order to understand maize QDS customers Cobb Douglass utility model was used and it was found that HH maize QDS demand across HH varied by expenditure on maize seeds; price of maize in informal seed sources; number of crops grown by HH; gender of maize producer; behaviour of using locally saved own seeds and from other farmers. involvement in off farm business and QDS recycling is known (Equation 13).

HH seed expenditure elasticity: HH expenditure on maize seeds has been found to have significant positive effect on quantity of QDS purchased by farmers. Farmers who spent more on maize seeds purchased more maize QDS. Maize QDS have been a necessary source of pure seeds of improved varieties for maize production from which part of harvest are used for seeds in next season as strategy to minimize maize seed costs.

Cross price elasticity: Maize QDS was found complementing locally saved seeds. As maize QDS used with locally and recycled seeds they add value of such seeds as a strategy to obtain cheap and own improved seeds for next season from their own farms. However, seeds in local markets have grades set according to quality based on last season experience; seeds with good attributes got higher price and in such situation farmers with access to such seeds had low demand for QDS.

HH crop diversity: It was found that as farmers had many crops in the farm less amount of maize QDS was purchased by HH. This is lack of crop specialization which induces competition of crops for farmers resource which in turn reduce allocation of HH resources to maize and hence reduced HH QDS purchase.

Gender: Among maize QDS customers, women producers have been found to have more use of maize QDs compared to men making QDS affordable source of seeds for women in maize production.

Off farm business: Also it has been found that household having off farm sources of income had more use of maize QDS use. This is due to the fact that off farm sources of income helps farmers to overcome income shocks associated with rain fed agriculture and therefore able to purchase more maize QDS.

QDS recycling: Households which used recycled QDS seeds have been found to have more maize QDS demand revealing that such farmers have some experience of QDS and therefore bought maize QDS more than farmers who purchased maize QDS for the first time.

4.5.2 Beans seed systems and market

a) Bean seed systems

This study provides cross sectional insights of market for bean QDS produced in Siha District and how highly bean seed system and use have been subjected to local seed systems. Siha District has more than 40 trained beans QDS producers. However, only 5.2 hectares were under bean QDS production in the district. Bean QDS production in Siha is faced by strong competition from farmer saved seeds and lack of awareness by most of beans producers on availability of quality bean seeds.

It was found that bean producers in Siha District were depending mainly on own saved seeds, buying seed from market centres or during market days (*gulio*), seed trade between farmers and nearby shops. Farmer own-saved seeds constituted 52% of all bean seeds used by respondents, followed by seeds obtained from market centers (36%), other farmers (10%) and nearby shops (3%).

Farmers more seeds of bean varieties with high price in the market. Yellow beans "soya njano" were the most grown and saved seeds followed by Kariasee and Lyamungo. However despite of their higher value in the market *Soya njano* and *Kariasee* beans varieties were not in QDS scheme because they were not yet improved and registered by TOSCI. Therefore among four varieties of beans produced through QDS scheme (Lyamungo 85, Lyamungo 90, Jesca and Pesa) only Lyamungo 85 and Lyamungo 90 beans were only produced by interviewing farmers.

Naming of varieties was another challenge in beans seed marketing due to differences in names given by breeders and the names used by farmers and traders in bean market. Lack of bean seeds in the formal seed market has caused farmers to use different names for one variety and different varieties were known by similar name. Good example was Lyamungo 85 and Lyamungo 90 beans which are collectively known as "*Lyamungo, Rosekoko or farm.* Farmers were not able to distinguish Lyamungo 85 and Lyamungo 90 due to their close similarities of colour.

b) Demand for bean seeds produced through QDS scheme

The demand for bean seed in Siha District increased from about 417 tons in 2007/08 to about 704 tons in 2011/12 season due to increase in bean hectares. This study shows that the demand for bean seeds of varieties produced through QDS scheme vary across households. HH demand for bean seeds of such varieties estimated using Cobb Douglas utility model shows that the demand for such seeds varied with HH access to price of such varieties (Lyamungo 85 and Lyamungo 90); number of bean varieties produced by HH, Access to extension service; Access of seeds from nearby shop and access to seeds from other farmers (Equation 18).

Own price elasticity: Through local system demand for Lyamungo 85 and 90 beans varieties was elastic with positive own price elasticity. This means that due to poor development of beans seed sector. Beans market operate as seed market near to sowing season and farmer reflect the market for bean varieties using the price of recycled seeds in the market. This finding means that due lack of formal supply of seeds, household demand for *Rosekoko* seeds increased as HH find higher price of such beans seeds. Informal sources of bean seeds act as an important source of market information for beans varieties since as household find seeds at a higher price they bought more seeds of a variety hoping to find higher price of its produce. However, using the price of beans bought for seeds as forecast for next season price is speculation about beans price in the market. This threatens the market for QDS especially for bean varieties with low price.

HH crop diversity: As beans producers increased the number of varieties they produced their reduced proportion of quantity *Rosekoko* seeds used. This was an indication of competition for household beans production resources between different bean varieties which in turn reduced demand for seeds from specific variety.

Access to extension services: Due to lack of formal bean supply for bean producers in Siha district extension officers have been recommending farmers to produce Lyamungo 85 and Lyamungo 90 bean varieties collectively as "*Rosekoko*" because they are improved varieties and is among bean varieties with high value in the market. Therefore household with contact with extension service used more quantity of *Rosekoko* seeds compared to household who had no contact with extension service in a production season.

Off farm sources of seeds: However due to lack of formal bean seed suppliers farmers had access to beans seeds through seed trade between themselves and therefore more *Rosekoko* bean seeds was demanded for household with access to bean seeds through exchange with other farmer or and through buying from nearby shops.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Uses of locally saved seeds consisting of recycled seeds still prevail in maize and bean production in Kongwa and Siha Districts respectively. Own saved seeds and from other farmers (i.e. seed sharing among farmers) are among local sources of seeds. However, bean seeds have also been acquired through local shops/kiosks and through buying from market at market centres or during market days (*gulio*). This finding indicates high competition from recycled seeds resulting in lower demand for quality seeds. Establishment of QDS schemes in study areas is among important initiative to promote the use of quality seeds in maize and bean production. However, the supply for QDS is low due to few QDS producers and shortage of land for seed multiplication.

Despite the role of QDS in ensuring quality seeds supply and employment for small scale seed producers in rural areas, QDS production and use are not included in important public intervention such as NAIVS scheme thereby lowering competition between QDS and locally saved seeds.

QDS trade has been restricted to be within a ward but no mechanism to prohibit such trade. QDS sellers can neither identify where all buyers comes from nor prevent customers from outside the ward to buy his/her QDS. Also due to the free market and improvements in marketing infrastructure QDS market has also expanded to beyond one ward boarder. Restriction of QDS trade beyond one ward boarder threatens more farmers to join in QDS production due to lower demand for seeds in the single ward market.

Shortage of land for QDS production limits small scale farmers from joining QDS production. Isolation distance of 190m required for maize QDS production restricts most of farmers from joining QDS production. In beans QDS production where 6m is required, isolation distance also is a challenge in Siha District because of shortage of land.

Dependence of rain water for QDS production and crop production limit QDS supply and use. Weather uncertainties hinder efforts of small scale farmers to invest in improved inputs due to high allocation of their income on off season family needs which lead them to bankruptcy at the time when they are required to buy improved inputs such as QDS. Weather uncertainties are also reasons behind poor attention of credit providers on QDS as well as small scale farming.

Despite of several challenges, QDS scheme is an important and reliable source of quality seeds for small scale crop producers at lower prices and proximity to their localities. In addition to that, QDS has become an important source of employment. Farmers who produced benefit more from maize production because they can sell seed at price higher than the prices of crop produces.

5.2 Recommendations

In order to establish strong and sustainable QDS production and market there is a need for coordination crop value chain actors. Participation of crop value chain actors from the initial stages of QDS production, training, production, awareness and marketing campaigns is crucial. Capacity of district councils to support QDS trainings, production, awareness creation and quality control is needed for sustaining QDS scheme. Public and private sector partnership is crucial in attaining this.

Maize and beans seed market must be separated from maize grains and bean grains market to ensure seed quality as well as seed security in rural areas. This principle of development of rural seed sector can simply be stated as "*seeds are grains but not all grains are seeds*". This should be stressed by all seed stakeholders. This can be achieved by improving farmers and small scale seed producers access to seed market information. Building capacity of rural seed suppliers through seed loans schemes is also recommended. Furthermore, registration of seasonal small input traders at district level to promote participation of seasonal input suppliers in QDS distribution is required. This will not only promote quality seeds use but also will promote the use of other improved inputs which complement quality seeds and will provide employment opportunity for rural people.

Despite of need for support to farmers, building capacity of farmers to solve challenges within their capacity such as lack of fund for purchasing improved inputs is crucial. This study recommends building capacity of farmers to save part of their agricultural income after selling their produce for purchasing improved inputs in the next season through improving access to financial services in rural areas. This can enable them to purchase quality seeds and other inputs and hence improve their productivity.

Improvement in supporting services such as public and private extension services, credit and risk management is recommended to support both QDS production and distribution. Capacities of farmers associations should also be built as an important tool through which innovations pass to farmers. These must go parallel with improvement in rural agricultural marketing infrastructures and mechanisms. For example, QDS scheme can be incorporated in the Warehouse receipt system (WRS) to facilitate contract QDS production between seed producers and crop producers.

Subsidizing inputs for small scale seed production or QDS is recommended to promote small scale QDS production and purchase by small scale farmers. Such interventions will lower QDS price and in turn make QDS more affordable to small scale maize producers.

Government should review of its regulations and procedures for QDS distribution are necessary especially to review the legal market for QDS. There has been noticed demand for QDS produced from one ward in other wards with similar agro climate. Therefore the legal market for QDS should be based on the adaptability of varieties instead of the administrative boundary. Districts and even regions with similar climatic condition can be assessed to become the legal market for QDS. Selling QDS within specified boundaries by QDS producers can be enforced by specification of legal area for use on a package label. This will help to prevent export of QDS from local market and will build QDS producers who concentrate on their local seed markets.

Legal enforcement is required in marketing agricultural produces especially in labeling of produces to promote the use of the original names of varieties. This will help to disseminate names as well as inducing uniformity in names for varieties of crops. This will help seed producers promote their seeds to farmers. Furthermore, QDS package labels should indicate areas where the seeds are suitable to be used to ensure farmers that they purchase seeds of right quality and right for their agro-climate.

There is need for TOSCI, district councils and other stakeholders to strengthen their coordination in controlling seed quality and sustaining QDS production and distribution system after initial establishment of QDS system.

Facilitation of investment on small scale irrigation schemes by public and private sector for off rain season QDS production (time isolation) should be stressed as an alternative solution to overcome the problems associated with distance isolation during cropping seasons. Even with small scale irrigation infrastructure time isolation can be possible where QDS producers can produce seeds twice per annum without depending on rain water.

Further research on QDS production and marketing for other crops and districts in Tanzania is vital. The emphasis of research should be on improving local varieties and technical skills of QDS producers, farmers, extension workers and seed suppliers. High demand for seeds from unimproved varieties calls for more breeding programme to improve such varieties so that farmers can access the seeds of their choice through QDS scheme. Greater coordination of stakeholders in the bean seed supply chain is required and new improved varieties need to be developed in participatory approach with farmers to make small scale commercial seed production viable.

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APPENDICES

Appendix 1: Glossary

Basic seed-Seed produced by a multiplication unit that is one or two generations after breeder seed but will be multiplied one more time to produce seed that will be sold to farmers.

Certified seed - The approved progeny of breeder or foundation seed managed to maintain satisfactory genetic identity and purity, the production of which is supervised and approved by the Tanzania Official Seed Certification Institute which provides the source for the initial and recurring increase of seeds; or if of foreign origin, that the seed is certified by a recognized certification agency. Seed that has been verified to be varietally pure, clean, and viable (high germination rate)

Composite seed - Composites are open-pollinated varieties selected from the random combination of a large number of recognized breeding lines that in theory have good combining quality and genetic characteristics desired for a specific location.

Crop diversity is the variance in genetic and phenotypic characteristics of plants used in agriculture. In crop diversity can be explained by number of crops produced by house hold per season.

Cross-price elasticity of demand measures the effect of a change in one good's price on the quantity of another good demanded. The cross-price elasticity of demand can be positive, in which case the goods are substitutes, or negative, in which case they are complements.

Farmers association-Institution established for the purpose of stressing the role of agriculture as primary means for support and sustenance of livelihood of its members. The institutions acknowledges other means of livelihood and work habits but stresses the importance of agriculture and farming, and was the most common form of socio-economic organization for most of recorded human history. Farmers associations often differ from institutions in other areas of the economy. Nevertheless it is often implicitly assumed that decision making processes of farmers are equal to those of other economic actors, with no differences in political implications.

Formal seed sector-The chain of seed production and marketing involving scientific plant breeding, multiplication by a seed company following established procedures, processing, bagging, labeling, and marketing

Foundation seed – The progeny of breeder seed; used as planting stock for registered and certified seed or seed produced by a multiplication unit that is one generation after breeder seed but will be multiplied again before being sold to farmers.

Hybrid seed-Seed produced by crossing two or more separate in-bred lines. Hybrid seed typically produces high yields the first year, but the yield drops if recycled for a second year.

Income elasticity of demand is the percent change in the quantity of a good demanded when a consumer's income change divided by the percentage change in income. The income elasticity of demand indicates how intensely the demand for a good responds to changes in income. It can be negative; in that case, the good is an inferior good. Goods with positive income elasticities of demand are normal goods. If the income elasticity is greater than 1, a good is **income-elastic**; if it is positive.

Informal seed sector-The chain of seed production and marketing involving farmers who save seed from harvest to planting, occasionally selling or exchanging seed with other farmers, but without any mechanical processing, testing, or labeling (as opposed to the formal sector).Sometimes called the farmer seed system.

Isolation – The separation of the field of seed crop from the field of other crops in order to prevent mechanical or genetic contamination of the seed to be harvested. Isolation could be in form of distance, time and physical barrier.

ISTA – The International Seed Testing Association that with its member laboratories establishes the international standards and procedures for seed testing.

Multiplication-The process of planting seed, growing the crop, and harvesting the next generation of seed, sometimes repeatedly over several seasons, in order to produce the desired quantity of seed for sale to farmers

Oligopoly – a market with only a few sellers or controlled by only a few sellers.

Open-pollinated variety - A heterogeneous variety of a cross-pollinated crop that is allowed to inter-pollinate freely during seed production; in contrast to hybrid seed production representing controlled cross pollination.

Open-pollinated variety - A heterogeneous variety of a cross-pollinated crop that is allowed to inter-pollinate freely during seed production; in contrast to hybrid seed production representing controlled crosspollination

Parastatal - An institution totally or partially owned by the government, which operates with some autonomy from the government bureaucracy.

Pre-basic seed-Seed produced by a multiplication unit that is one generation after breeder seed and will be multiplied again before being sold to farmers.

Pure seed – Refers to the species stated on the label or found to predominate in the test and shall include all botanical varieties and cultivars of that species including both whole seed, immature seed, diseased seed, and seed larger than one-half their original size or as defined by ISTA rules for seed testing

Pure seed - The species stated on the label or found to predominate in the test and which includes all botanical varieties and cultivars of that species, including whole seed, immature seed, diseased seed, and seeds larger than one-half of their original size, or as defined by ISTA rules for seed testing.

Registered seed - A class of seed in a certified seed scheme that is produced from foundation seed and planted to produce certified seed.

Seed – The ripened ovule consisting of an embryonic plant together with a store of food or other structure including the ovule used by farmers as planting material.

Seed act - A piece of legislation that establishes the basic rules for the production and distribution of seed in the country.

Seed multiplication - The process used for increasing the breeder seed in the quantity required while maintaining the original genetic characteristics.

Seed replacement-The practice of purchasing the seed of a given variety to protect against yield loss associated with accidental mixture and seed-borne diseases. Seed replacement is one of the two sources of demand for purchased seed, the other being varietal change.

Seed system- Also called the seed industry, are the set of interconnected institutions involved in developing new varieties and producing, testing, certifying, and marketing seed to farmers. Although some of these functions, such as certification, are not performed by the informal sector, the informal sector is part of tne seed system.

Self-pollinating species-A plant species in which the majority of pollination occurs within the same plant (as opposed to cross-pollinating species). Examples of self-pollinating species are wheat, rice, chickpeas, and groundnuts. Sorghum, cowpea, beans, and pigeon pea are predominantly self-pollinating.

Standard seed-A category of seed in some seed quality control schemes which may be tested but is not subject to full certification procedures.

Transaction costs-The costs of carrying out a transaction for the buyer and seller, including the costs of searching for someone to trade with, inspection of the good, negotiating the terms of the transaction, and monitoring compliance with the agreement

Variety - Synonymous with the term "cultivar" as defined in the International Code of Nomenclature for Cultivated Plants, 1980, Art. 10:"The international term cultivar denotes an assemblage of cultivated plants which is clearly distinguishable by a group of characters (morphological, physiological, cytological, chemical or others) and which, when reproduced (sexually or asexually), retains its distinguishing characteristics."

Appendix 2: questionnaire (For maize producers)

Date.............................. District............................Ward.............................Village..............................

A10 Respondent household characteristics (Tick or write an appropriate Figure)

A101 Number	A102 Sex of HH head		A103 Age	A 104 Household size	105 Any other employment apart from Agriculture	
	F(0)	M (1)			No (0)	Yes(1)

106 Education level						A107 Respondent experience in maize farming (Years)
Not able to read/write (0)	Primary (1)	Sec. (2)	Cert(3)	Diploma (4)	Degree and above (5)	108 Household members available for working in the farm

109 Asset ownership				Bicycle (0)	Motor vehicle(1)	Tractor(2) Oxen (3)
Ox-plough(4)	Water tank (5)	Scotch-cart(6)	Mobile phone (7)	House(8)	Television (9)	Radio (10) Wheelbarrow(11)

A110 Household income

Agriculture				**Other sources**	
Source (e.g crop/livestock e.t.c	Area crop (Acres).	2011/12 Quantity sold (specify unit)	Price per unit (Specify unit)	Other sources of income	Income generated per season/year
Cattle				Salary	
Sheep				Others (Specify)	
Goat					
Chicken					
Maize					
Sunflower					
Sesame					
Beans					
				A 110 Total income/yr	

A111 What is your primary source of income				
Not defined (0)	Employment (1)	Crop production (1)	Livestock keeping (2)	Others Specify (3)

A20 Farm characteristics (Fill black cell with appropriate information)

A201 Total land owned by household (Acre)	Land rented		A204 Area allocated for crop production (Acre)	A205 Area allocated for maize production (Acre)	A206 Maize plant spacing (in Metre)	A207 Number of crops grown (Crop diversity) (Count A107)
	A202Land rented in (Acre)	A203Land rented out (Acre)				

A30 Institutional membership, use and supports

31 Organization membership (Tick where appropriate) No (0)............Yes (1).................					
32 Received extension service in 2011/12(Tick where appropriate) No (0)............Yes (1)................					
Group (1)	SACCOS (2)	Farmers Association (3)	Primary cooperative society (4)	Others (Specify below) (5)	
		A33 Have you ever borrowed money or any asset for investing in Agriculture		34 Did you get Input voucher in last season	
		No (0)	YES (1)	No (0)	YES(1)

A40 Input use

Source of maize seeds

Source of seed	A401 Method of exchange			A402 Cost of seeds		A403 Amount (Kg)	A404 Area planted (Acre)
	Free (0)	Barter (1)	Money (Cash) (2)	Price (Tsh)	Commodity exchanged with seeds and how much of it per unit of seeds		
Own saved seeds (0)							
Neighbors/other farmer (1)							
Market days (Gulioni) (2)							
Nearby shop/Kiosk (3)							
Market centre (4)							
Input supply stores • In a ward/nearby (5)							
• At district capital (6)							
Extension officer (7)							
Others (Specify (8)							
Total							
Seeds supplied to other farmers							**N/A**

Maize varieties use (Varieties diversity)

A405 Variety of maize	A406 Area planted (Acre)	A407 Price of seed (Tsh)	A408 Quantity of seeds used (Kg)	A409 Production (in 100Kg bags)	A410 Price of maize per bag (Tshs)
Local varieties (0)					
Kilima (1)					
TMV1 (2)					
Staha (3)					
Stuka (4)					
Hybreed seeds (5)					
Other (specify) (6)					
Total					

A405b. Names of local varieties grown..

Maize QDS use

Varieties	A411 Source of purchasing (use A401 to code sources)	A412 Ranks of varieties preference	A413Quantity of QDS used (Kg)	A414Price per Kg	A415Area planted (Acres)	A416 2010/11 season Production (100kg bags)	A417 2011/12 Production (bags of 100Kg)
Kilima							
TMV1							
Staha							
Stuka							

Use of other inputs, costs and technology use in maize production

Categories of costs	A 419 Details	A420Cost (Tsh per Acre)	A421 Technology use (Tick where appropriate)			
			Manpower /Hand tools (0)	Animal power (1)	Tractor power (2)	Other (specify) (3)
A422 Agronomic activities	Land preparation (0)					
	Sowing (1)					
	Weeding (2)					
	Spraying (3)					
	Fertilizing (4)					
	Harvesting (5)					
	Post harvest processing cost per 100kg bag (6)					

A423 Input cost	Pesticide (for field application) (0)					
	Fertilizer (1)					
	Manure (2)					
A424 Other costs (Specify)						

A424Do you have an access to irrigation? A426How much area under maize production do you irrigate?....................Acres	No (0)	Yes (1)
A425Do you intercrop maize with any other crop A426How much acreages of maize intercropped in 2011/12................Acres	No (0)	Yes (1)

A50 Perception, challenges and suggested solution

A501 Do you think QDS can be solution for ensuring seeds availability in your locality compared to other seed schemes? (Perception on QDS) No (0)....................... Yes (1)........................

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A 502 If QDS scheme is not the solution (state why)

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A503 Benefits obtained by respondents after using QDS

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A503 What are challenges facing you in accessing quality seeds for maize/beans	A504 What do you think can be done (in relation to access of quality seed) to improve your current situation? (List)	A505. Are you willing to allocate your land and effort to produce QDS		A506 Are you willing to buy QDS seeds from other farmers (who will produce/sell)?	
		No (0)	Yes (1)	No (0)	Yes (1)

production (list)		Reasons	Reasons	Reasons	Reasons

THANK YOU VERY MUCH

Appendix 3: Questionnaire (For bean producers)

Location of respondents

Date.............................. District............................Ward.............................Village..............................

A10 Respondent household characteristics (Tick or write an appropriate Figure)

A101 Number	A102 Sex of HH head		A103 Age	A 104 Household size	105 Any other employment apart from Agriculture	
	F(0)	M (1)			No (0)	Yes(1)

106 Education level						A107 Respondent experience in beans farming (Years)
Not able to read/write (0)	Primary (1)	Sec. (2)	Cert(3)	Diploma (4)	Degree and above (5)	108 Household members available for working in the farm

109 Asset ownership				Bicycle (0)	Motorcycle (1)	Tractor(2) Oxen (3)
Ox-plough(4)	Ox-cart(6)	Water pipe (7)	Car (5)	House(8)	Television(9)	Radio (10) Wheelbarrow(11)

A110 Household income

Agriculture				Other sources	
Source (e.g crop/livestock e.t.c	Area crop (Acres)/No of animals	2011/12 Quantity sold (specify unit)	Price per unit (Specify unit)	Other sources of income	Income generated per season/year
Cattle				Salary	
Sheep				Others (Specify)	
Pig					
Goat					
Chicken					
Maize					
Sunflower					
Sesame					
Beans					
Coffee					
Plantain					
				A 110 Total HH income/yr	

A111 What is your primary source of income				
Not defined (0)	Employment (1)	Crop production (1)	Livestock keeping (2)	Others Specify (3)

A20 Farm characteristics (Fill black cell with appropriate information)

A201 Total land owned by household (Acre)	Land rented		A204 Area allocated for crop productio n (Acre)	A205 Area allocated for maize production (Acre)	A206 Plant spacing	A207 Number of crops grown (Crop diversity) (Count A107)
	A202Land rented in (Acre)	A203Land rented out (Acre)				

A20 Farm characteristics (Fill black cell with appropriate information)

A201 Total land owned by household (Acre)	Land rented		A204 Area allocated for crop producti on (Acre)	A205 Area allocated for maize production (Acre)	A206 Plant spacing	A207 Number of crops grown (Crop diversity) (Count A107)
	A202Land rented in (Acre)	A203Lan d rented out (Acre)				

A30 Institutional membership, use and supports

Organization membership (Tick where appropriate) No (0).............Yes (1).................					
Received extension service in 2011/12 season (Tick where appropriate) No (0).............Yes (1).................					
Group (1)	SACCOS (2)	Farmers Association (3)	Primary cooperative society (4)	Others (Specify below) (5)	
	A203 Have you ever borrowed money or any asset for investing in Agriculture		A204 Did you get Input voucher in last season		
	No (0)	YES (1)	No (0)	YES(1)	

A40 Input use

Source of maize seeds

Source of seed	A401 Method of exchange			A402 Cost of seeds		A403 Amount (Kg)	A404 Area planted (Acre)
	Free (0)	Barter (1)	Money (Cash) (2)	Price (Tsh)	Commodity exchanged with seeds and how much of it per unit of seeds		
Own saved seeds (0)							
Neighbors/other farmer (1)							
Market days (Gulioni) (2)							
Nearby shop/Kiosk (3)							
Market centre (4)							
Input supply stores • In a ward/nearby (5)							
• At district capital (6)							
Extension officer (7)							
Others (Specify (8)							
Total							
Seeds supplied to other farmers							N/A

Maize varieties use (Varieties diversity)

A405 Variety of beans	A406 Quantity of seeds used (Kg)	A407 Price of seeds (Tsh)	A408 Area planted (Acre)	A409 Production (in 100Kg bags)	A410 Price of beans per 100 kg bag (Tshs)	A411 Seed reserve for next season (Kg)
Soya njano						
Rose koko						
Ngariasee						
Soya kijivu						
Msoline						
Kibukoba						
Kanamna						
Kanada						
Karanga ndogo						
Bwana Shamba						
Total						

A412 Number of varieties of beans grown by respondent in last season..............................

Use of other inputs, costs and technology use in maize production

Categories of costs	A 419 Details	A420Cost (Tsh per Acre)	A421 Technology use (Tick where appropriate)			
			Manpower /Hand tools (0)	Animal power (1)	Tractor power (2)	Other (specify) (3)
A422 Agronomic activities	Land preparation (0)					
	Sowing (1)					
	Weeding (2)					
	Spraying (3)					
	Fertilizing (4)					
	Harvesting (5)					
	Post harvest processing cost per 100kg bag (6)					
A423 Input cost	Pesticide (for field application) (0)					
	Fertilizer (1)					
	Manure (2)					
A424 Other costs (Specify)						
A424Do you have an access to irrigation?					No (0)	Yes (1)
A426How much area under beans production do you irrigate?...................Acres						
A425Do you intercrop maize with any other crop					No (0)	Yes (1)
A426How much acreages of beans intercropped in 2011/12................Acres						

A50 Perception, challenges and suggested solution

A501 Do you think QDS can be solution for ensuring seeds availability in your locality compared to other seed schemes? (Perception on QDS) No (0)................. Yes (1)................(2) Not aware of QDS................

A 502Reasons

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A503 What are challenges facing you in accessing quality seeds for maize/beans production (list)	A504 What do you think can be done (in relation to access of quality seed) to improve your current situation? (List)	A505. Are you willing to allocate your land and effort to produce QDS		A506 Are you willing to buy QDS seeds from other farmers (who will produce/sell)?	
		No (0)	Yes (1)	No (0)	Yes (1)
		Why	Why	Why	Why

THANK YOU VERY MUCH

Appendix 4: Check list (Village/Ward Agricultural extension officer)

B10Village characteristics

District		Ward	Village	Date	Respondent number
Kongwa	Siha				

B101 Village Population		B102 Number of households in the village	B103 Number of household growing maize/bean	B104 Potential area for Agriculture (Ha)	B105 Total area under cultivation in the village (Ha)	B106 Total area under maize/ Beans in the village (Ha)	B107 Village total maize/beans harvest (Tons)	Number of input suppliers	
F (0)	M (1)							B108 In the ward	B109 In the village

B110 Number of maize/beans production seasons in a year		B111 Number of Institutions					B112 No of market days (gulio) per month	B113 Number of Market centres in the ward
One (0)	Two (1)	Groups (0)	Farmers association (1)	SACCOS (2)	Primary Coop. society (3)	Others (Specify) (4)		

B20 Maize/Beans production report

	Years							
	2008/2009		2009/2010		2010/2011		2011/12	
	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2	Season 1	Season 2
B201 Planted areas (Ha)								
B202 Seeds demanded (tons)								
B203 Recommended seed rate								
B204 Recommended plant spacing								
B205 Quality Seeds used (tons)								
B206 Number of tractors								
B207 Irrigated area (Ha)								
B208 Annual rainfall (mm)								
B209 Number of tractors								
210 Animals powered machines								
210 Harvest (Tons)								
211 Number of farmers given Input Voucher in last season								

THANK YOU VERY MUCH

Appendix 5:Checklist for QDS producers

Date............................ District............................Ward............................Village.............................

C10 Respondent household characteristics (Tick or write an appropriate Figure)

C101 Number	C102 Sex of HH head		C103 Age	C 104 Household size	C105 Other employment apart from Agriculture		
	F(0)	M (1)			No (0)	Yes(1)	
C106 Education level						C107 Respondent experience in maize farming (Years)	
Not able to read/write (0)	Primary (1)	Sec. (2)	Cert(3)	Diploma (4)	Degree and above (5)	108 Household members available for working in the farm	
109 Asset ownership				Bicycle	Motor vehicle	Tractor animals	Draught
Ox-plough	Water tank	Scotch-cart	Mobile phone	House	Television	Radio Wheelbarrow	

A110 Household income

Agriculture				Other sources	
Source (e.g crop/livestock e.t.c	Area crop (Acres).	2011/12 Quantity sold (specify unit)	Price per unit (Specify unit)	Other sources of income	Income generated per season/year
Cattle				Salary	
Sheep				Others (Specify)	
Goat					
Chicken					
Maize					
Sunflower					
Sesame					
Beans					
Other (Specify)					
				A 110 Total HH income/yr	
A111 What is your primary source of income					
Not defined (0)	Employment (1)	Crop production (1)	Livestock keeping (2)	Others Specify (3)	

C20 Farm characteristics (Fill black cell with appropriate information)

C201 Total land owned by household (Acre)	Land rented		C204 Area allocated for crop production (Acre)	C205 Area allocated for maize production (Acre)	C206 Area allocated for maize QDS production	C207 Number of crops grown (Crop diversity) (Count A107)
	C202Land rented in (Acre)	C203Land rented out (Acre)				

C30 Institutional membership, use and supports

C301 Organization membership (Tick where appropriate) No (0)............Yes (1)................						
Group (1)	SACCOS (2)	Farmers Association (3)	Primary cooperative society (4)		Others (Specify below) (5)	
		C203 Have you ever borrowed money or any asset for investing in Agriculture		C204 Did you get Input voucher in last season		
		No (0)	YES (1)	No (0)	YES(1)	

C40. Technology use in QDS production (Put V wherever appropriate)

Technology	Farm activities						
	Land preparation	Sowing	Weeding	Fertilizing	Harvesting	Transporting	Post harvest processing
C401 Hand implement							
C402 Animal power							
C403 Tractor power							

C50 Post harvest technology use in QDS business

	C501 Post harvest processing	C502 Pesticides for seeds treatment	C503 Seed treatment	C504 Parkaging	C505 Packing	C507 Transport to market	C508 Others(Specify if any)
Machine owned by a group							
Machines hired in							
Cost of hiring in/out (If any)							

C60 Marketing and customers management

C601 Groups of customers	C602 Mode of distribution to customers	C603 How price of QDS is set	C604 Sizes of packaging material	C605 Price of QDS	C606 Brand name		C607 Promotion strategies
					Registered	Unregistered	

C70 Challenges and suggestions

700 Benefits of QDS to respondents	C701Challenges facing QDS production	C702Strategies to overcome challenges	703Can you get access to more land for produce QDS		C704Suggestion to other QDS stakeholders
			NO (1)	YES (2)	
			Reasons	How	

THANK YOU VERY MUCH

Appendix 6: Checklist (For Agro-dealers)

District	Ward	Village	Date of interview	Respondent number

Maize QDS production in the ward?	No (0)	Yes (1)

D11 Experience in Agro-input supply (Yrs)	D12 Which crop seeds do you supply?	D13 Have you ever borrowed money from bank or any financial institution to invest in Inputs supply	
		NO (0)	YES (1)

D4 Maize varieties	Certified Seeds				QDS			
	D5 Buying price	D6 Selling Price	D7 Total stock from suppliers	D8 Quantity sold	D9 Buying Price	D10 Selling price	D11 Total stock from suppliers	D12 Quantity sold
Total								

How do you get supply of QDS?	Own production	Direct from producers	Wholesalers	
If supply is direct from QDS producers, How do you trade with QDS producers?	Contract farming	Order after harvest	Visiting producer to buy	Personal selling by producers direct to your store.
How QDS varieties are preferred in order (Put 1, 2..... from highest to lowest preferred)	Kilima	Stuka	Staha	TMV1
Who supplies you with maize QDS?	ZOSEM(0)		Other seed producers?(1) (Name ward they come)	

Who set QDS price?		
You (Input supplier) (0)	QDS buyers(2)	QDS producers(5)
	Government(3)	Follow certified seeds subsidized price(6)
Negotiation with buyer (1)	Follow certified seeds unsubsidized price(4)	Other (Specify)(7)

Do QDS customers real know difference between QDS and other seeds?	No (0)	Yes (1)

13 Are you registered to supply input under Input Voucher scheme		D15 Do you think QDS the best solution for ensuring seeds availability to farmers?		D16 What are reasons for answer in D 14.
NO (0)	YES (1)	NO (0)	YES (1)	
D17 What are challenges facing seeds marketing?		D18 What are specific challenges facing QDS marketing?		

D19 What can be done to promote QDS?

Appendix 7: Checklist for District Council

District council beans/maize production data

Districts (Tick where appropriate)	Kongwa (For maize)						
	Siha (For beans)						
YEARS	2005/06	2006/7	2007/8	2008/9	2009/10	2010/11	2011/12
Area							
Number of wards							
Numbers of villages							
District population							
Number of maize producing households							
Total area used for crop production (Ha)							
Area planted with maize/beans (don't include QDS prdctn) (Ha)							
Seed demand (Tons)							
Quality seeds used (Tons)							
QDS produced (Tons)							
Organic Fertilizer use (tons)							
Inorganic fertizer use (tons)							
Number of tractors							
Insectcides (Litters)							
Herbicides use (Littres)							
Irrigatied area (Ha)							
Number of registered Input suppliers							
Number of extensionists							

Crop production

Crop	Area (Hactres)	Output (Tons)	Recommended output/Ha

Do you think QDS can be solution for ensuring seeds availability in your locality compared to other seed schemes? If yes why?

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What are challenges facing development of QDS scheme in your district

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What are districts strategies to overcome challenges facing QDS?

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THANK YOU VERY MUCH