A FARM LEVEL IMPACT ASSESSMENT STUDY OF THE TANZANIA BEAN RESEARCH PROJECT TECHNOLOGIES: THE CASE OF MOROGORO AND KILOSA DISTRICTS.

BY

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ABSTRACT

The purpose of this study was to assess the farm level impact of the technologies introduced by the Tanzania Bean CRSP (Collaborative Research Support Programme) Project to small holder farmers in Morogoro and Kilosa Districts in Tanzania. Data for the study were collected, through interviews of 277 farmers in seven villages of the two districts in relation to the production and consumption of bean in the 1994/95 and 1995/96 cropping seasons. The study has mainly traced the adoption process and impacts of SUA 90 bean variety (a variety which was released by the project in 1990). The study also presents quick reviews of the other technologies developed by the project which include; NITROSUA (a substitute to chemical fertilizer) and EP4-4 bean variety.

The study uses a variety of analytical tools in assessing the data and information collected. The tools include: descriptive statistics, econometric models, and qualitative assessments. The study results reveal that in the sample area beans are mainly produced by small holder farmers who cultivate an average farm size of 3.2 ha of which 0.5 ha is devoted to beans production. Out of the total sample of farmers, who have had exposure/access to SUA 90- variety, 60% of these have adopted the variety (out of which 43% are women). EP4-4 variety and NITROSUA were found to be less known by farmers. About 48% of the adopters produce beans as a principal crop and about 74% of all the farmers who received SUA 90 seed, mentioned that they are ready to cultivate the variety. Results also show that the adoption of SUA 90 bean variety is influenced by factors related to the perception of farmers on palatability, yield performance and cooking time. Other variables which affect the adoption of SUA 90 related to age of the farmer, his income from selling crop and total farm size owned. Extension contacts, perception on seed colour, seed size, broth quality and keeping quality exhibited no significant association with the SUA 90 variety adoption decision. On the other hand, the amount of local varieties consumed and farmer's perception on palatability and cooking time are associated with the consumption level of SUA 90 bean variety. Other factors include; area planted with SUA 90, amount of SUA 90 yield, yield of local varieties, area planted with SUA 90, amount of SUA 90 seed sold and farmer's perception on broth quality. The quantitative results also show that the household size, total farm size, extension contact, total bean plot size, area planted with SUA 90, area under local varieties, age of the farmer, adaptability of the variety to bad weather and average income, explain the observed variation in SUA 90 yield.

The study concludes that SUA 90 bean variety has been accepted by farmers and it exhibits impacts on smallholder farmers' income and welfare. The variety is preferred for its consumption qualities as shown by a large number (70%) of farmers who consumed it and commended its palatability. Overall however farmers were disappointed with the limited/small supply of seed for their use and they wanted to see some improvement.

The study's recommendations are that; (I) the CRSP project should design an institutionally based mechanism to ensure adequate and timely supply of SUA 90 seed; (ii) more effort should be channeled towards the multiplication of seed to satisfy the demands of the rural farmers. (iii) to continue to incorporate farmers' evaluations in the project's breeding programmes in order to come up with technologies with acceptable qualities to farmers; (iv) to institute a system of continuous monitoring and collection of data for impacts of the released technologies. The project should also promote and advertise the technologies developed. An additional recommendation of the study is that a deeper impact assessment study of the project should be conducted after three of five seasons (from 1994/95) to obtain a clearer understanding of the adoption process and impacts of the introduced project technologies.

DECLARATION

I Vera Florida John Mkenda, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own work and has never been submitted nor concurrently being submitted for a degree at ay other university.

Signed ....

Date............................21/10/1997.........................

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DEDICATION

This work is dedicated to my Beloved parents for their many sacrifices and to Kefas, Dennis and the little Kelvin who was born during the study for their love and inspiration throughout the study period.

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LIST OF ABBREVIATIONS

Agric.	Agriculture
a.s.l	above sea level
BCMV	Bean Common Mosaic Virus
CBA	Cost Benefit Analysis
CIAT	Centre International Agricultural Tropical (International Tropical Research Center)
CRDB	Cooperative and Rural Development Bank
CRSP	Collaborative Research Support Programme
FPR	Farmer Participatory Research
ha	hectare
IARC	International Agriculture Research Centers
kg	kilogram
MDB	Marketing Development Bureau
NARS	National Agricultural Research Systems
NBC	National Bank of Commerce
NGO	Non Governmental Organisation
NMC	National Milling Corporation
OLS	Ordinary Least Squares
PVO	Private Voluntary Organisation

ROR	Rate of Return
SPSS	Statistical Package for Social Sciences
SUA	Sokoine University of Agriculture
TANSEED	Tanzania Seed Company
TDT	Technology Development Transfer
THU	Tractor Hire unit
T & V	Train and Visit
TOSCA	Tanzania Official Seed Certification Agency
TShs.	Tanzanian Shilling
UMADEP	Upper Mgeta Agricultural Development Project
UMHODEP	Upper Mgeta Horticultural Development Project
UNDP	United Nations Development Programme
US	United States
USA	United States of America
USAID	United States Agency for International Development
USD	United States Dollar
WSU	Washington State University

CHAPTER ONE

INTRODUCTION

1.1 Background Information

This is a study on adoption, effect and general impact of specific technologies developed by the Tanzania Bean CRSP (Collaborative Research Support Programme) Project for the purpose of improving farmers' well being at a household level in Tanzania.

Impact assessment of overall farm research and specific tested farm technologies is a relatively new and complex subject (Kashuliza, 1994). It entails the quantification of socio-economic benefits generated from the new knowledge produced by research (technologies), as well as measuring the costs of producing and using the technologies.

As pointed out by Echeverria (1992: cited by Kashuliza 1994), there are three main reasons for evaluating agricultural research, (i) to take a look at the future (*ex-ante*) -to assist in effective research planning, both at the project and programme level; (ii) to look at the present (on-going) - to guide the development of effective research and technology policies; (iii) to take a look at the past (*ex-post*) - to estimate the research pay off, usually for the purpose of justifying financial support for future research. But the overall economic rationale for research evaluation and impact studies is to improve efficiency in the allocation of research resources.

The Tanzania Bean CRSP (Collaborative Research Support Programme) Project is a bean improvement project implemented in two countries i.e Tanzania and USA under the auspices of Bean/Cowpea CRSP funded by United States Agency for International Development USAID. This project is also known as the Sokoine University of Agriculture - Washington State University Bean CRSP Project (SUA - WSU Bean CRSP Project), bearing the names of the universities where the project activities are based in the participating countries. In this study the project is also referred to as the SUA Bean Project.

The Tanzania Bean CRSP Project was established in Tanzania in 1982. The project coordinates research on common bean crop which is a pulse normally grown in the tropics by a majority of small holder farmers. The common bean, *Phaseolus vulgaris L.* is a self-pollinated New World crop which was introduced into Eastern Africa 400 years ago (Edje *et al.*, 1981; Gepts, 1984; cited by Ferguson and Sprecher, 1989). The main problems which are addressed by the project include; (i) low yield (ii) diseases (iii) pests (iv) drought and (v) low income and poor nutritional status of small holder farmers. Since its establishment three important technologies have been developed and tested through the project. They include SUA 90 bean variety, EP4-4 bean variety and NITROSUA (a substitute to fertilizer use in bean production).

In Tanzania beans are mainly grown in wet regions with low altitude ranging between 400 - 1500 m a.s.l. The main bean producing regions in the country are Kagera, Shinyanga, Iringa, Kigoma, Rukwa, Mbeya, Arusha and Kilimanjaro (MDB Report, 1993). However substantial productions have been reported in other regions like Lindi, Morogoro, Mtwara, Mwanza , Tabora, Tanga and Ruvuma (MDB, *opicit*).

The production of beans in Tanzania is mainly a subsistence undertaking in which only a small surplus is obtained for the market. However, a substantial proportion of beans is sold on the market, particularly in the urban centers throughout the country. This is so because farmers are in need of cash to purchase the industrial consumer goods which they do not produce but they consume. Therefore, apart from its primary role in supplying essential nutrients, bean is also commercially important, i.e. though the primary objective of small farmers in producing beans is for home consumption, it is also of importance in generating household income.

The general approach of the impact assessment study of the Tanzania Bean CRSP Project varieties and technologies is of conducting a study to compare the situation 'with' and 'without' the introduction of the technologies. The assessment is based on assessing the number and type of farmers who adopted the technologies, the pattern and rates of adoption, impacts on income and farm productivity. Generally the assessment aims at documenting and measuring the positive and negative effects of technological adoption from different dimensions including social and economic and hence establish the impact of the project.

1.2 Research Problem

For the recent past, there has been a general decline in research budgets for most developing countries, while alternative uses of funds have been increasing. As a result researches with high net returns or pay-off are likely to be given priorities as compared to the less paying ones. In addition, the need for greater accountability and improved research management, call for impact assessment of research activities and programmes.

Since its establishment in 1982, the SUA Bean Project has aimed at contributing to the well being of the bean producers (as documented in the SUA-WSU Bean CRSP Annual Reports, 1992-1994). However, presently it is not clearly known whether the intended aims of the project have been achieved or not. In addition, no intensive study has been conducted to assess the adoption rates and the broader impacts of the introduced technologies. This study intends to contribute to that cause. Furthermore, results of the proposed study have potential to contribute to decision making on whether further investment in this and related projects is justifiable or not.

1.3 Justification for the Study

Over the past 20 years, USAID and other donors have given priority to strengthening national agricultural research systems (NARs) and have made a considerable investments in African Technology Development and Transfer (TDT) activities (Bernsten *et al.*, 1992; Oehemke *et al.*, 1993). According to Bernstein *et al.* (1992) donors have pursued this strategy because they believed that lack of new technology was a major constraint to agricultural development; that research institutions in developing countries lacked the capacity to generate new technology; and that investments in agricultural research generated a high rate of return (ROR). Therefore strengthening NARs would have an enhanced capacity to generate new agricultural technologies which would, in turn, accelerate agricultural development.

Initially, support for the hypothesis that agricultural research generates a high ROR was largely based on historical evidence from the US, Western Europe and Australia and more recently in Asia and some countries in Latin America as evidenced by relatively rapid increases in per capita food production. In contrast, there is less evidence for Sub-Saharan Africa. Despite many years of substantial donor investment, per capita food production has declined steadily since 1960 (Bernstein *et al.*, 1992). Many factors that have contributed to the poor performance of African Agriculture have been documented (see Eicher, 1990).

While few observers doubt that agricultural research has the potential to accelerate agricultural development, in light of the current institutional and political environment, donors are now asking the question - "At this point in time, is agricultural research a "good investment in Sub-Saharan Africa?" (Bernsten *et al.*, 1992).

Therefore to answer this question it is very important for all projects (and programmes) to evaluate their performance and justify or contradict what Oehemke *et al.*, (1992) calls "a perception" that agricultural research is not a good investment in Africa and hence insufficient to justify continued funding. This is important because as pointed out by Collinson and Tollens (1994), Kashuliza (1994) and Anandajayasekeram *et al.*, (1993), at the aggregate level, the use of research evaluation provides a basis for optimizing levels of investment in research. The question of how to invest in research is important because under-investment in research will result in forgoing potential output and the associated welfare gains to the society, while over-investment will result in sacrificed output and associated welfare losses due to the misuse of resources.

In line with such facts and with recommendations put forward by the Bean/Cowpea CRSP External Evaluation Panel in 1992, it was found imperative to conduct a farm level impact assessment of the SUA Bean/CRSP research both as; a response to

USAID's increasing interest in evidence of impact; and as evidence of a positive impact to the research investment and a justification for continued funding.

Furthermore, since the main objective of the SUA Bean Project was to develop multiple disease and insect resistant cultivars of beans and to evaluate their socio-economic viability in the context of the small-holder farm family, and to improve the bean production, consumption and profitability to the farmers, then to ensure successful development of the bean cultivars to small-holder farmers under the SUA Bean research programme, it is of paramount importance to evaluate the project activities overtime and thereby contribute to the future viability of the project and the technologies being tested.

Results of this study have potential to contribute to the design of effective research and technology policies, and to guide research planning at both the project and programme level.

1.4 Study Objectives

The main objective of this study is to assess the impact of the technologies introduced by the SUA Bean Project to small holder farmers in Morogoro and Kilosa districts.

Specific objectives of the study are:

a) To assess the adoption process and diffusion of SUA 90 bean variety and related bean project technologies.

b) To establish the impacts of SUA 90 bean variety and related technologies on small holder farmers.

c) To evaluate the consumption pattern of SUA 90 variety *vis-a-vis* other varieties.

d) Following from the above objectives to post suggestions which will accelerate the adoption and impacts of the bean project tested technologies.

1.5 Hypotheses

The following normative hypotheses have guided the implementation of this study;

i) SUA 90 bean variety has been adopted by small holder farmers and have replaced some local bean varieties

ii) SUA 90 bean variety exhibits a positive impact on crop yield and incomes of small holder farmers.

iii) SUA 90 bean variety is preferred by consumers in comparison to local varieties due to its superior characteristics.

iv) NITROSUA, EP4-4 and other technologies at the SUA Bean Project have contributed to farmer's wellbeing.

1.6 Organization of the Thesis

The thesis is divided into five chapters. **CHAPTER ONE** contains the background information of the study, a general overview on impact assessment, the research problem, justification for the study, study objectives and hypotheses guiding the study.

CHAPTER TWO gives a brief review on literature related to this study. The chapter begins by a summary of the status of the bean crop production, marketing and consumption in Tanzania. The chapter also reviews the theory behind agricultural innovations adoption and the literature on factors influencing adoption. Different qualities required by bean farmers and factors related to farmers' preference and choice in bean production, consumption and marketing, like seed colour, seed size, cooking quality, resistance to diseases, tolerance to unfavourable weather, palatability and tastes etc., are summarised in this chapter. Literature on factors affecting bean yield have also been reviewed. Different methodologies that are used to measure economic and social impacts, including those used to measure adoption and diffusion of technologies are discussed at the end of chapter two.

CHAPTER THREE presents the methodologies employed including a brief description of the study area and a short history and activities of the SUA Bean Project with a brief description of the technologies developed by the project. Farmer sample, study location, data collection tools and techniques are described in this chapter. Data analysis procedures including descriptions of the models used are presented and discussed.

Study findings from both qualitative and quantitative analyses together with their respective discussions based on the study objectives, are presented in **CHAPTER FOUR**. The conclusions and recommendations of the study are summarised in **CHAPTER FIVE**. References and appendices are given at the end of the thesis.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter begins by describing the status of bean crop in Tanzania, ranging from production, marketing, and consumption. Problems facing bean research in Tanzania are also presented. It also reviews the literature on the process and factors influencing technology adoption decision and rates. Studies on preferential factors associated with production, consumption and marketing of beans in Tanzania are also reviewed. The chapter concludes by reviewing methodologies used to measure adoption, and impacts of different technologies which guided the selection of the methodology used in this particular study.

2.2 The Status of Bean Crop in Tanzania

The Tanzanian economy like those of many other third world countries is predominantly agrarian, based on subsistence farming. Agriculture being the most important sector of the economy, employs approximately 84 percent of the economically active population, contributes 57 percent of the GDP and earns 80 percent of the annual foreign exchange earning (World Development Report, 1996 cited by Mlambiti and Isinika, 1997). The World Bank Country Study (1994: cited by Mlambiti and Isinika, 1997) observed that Tanzania's 3.5 million farm families work small holdings with an area cultivated averaging 0.9 hectares and some 93 percent of all farmers cultivating less than 2.0 hectares.

2.2.1 Bean Production in Tanzania

The main cash crops produced in the country include coffee, cotton, pyrethrum, sisal, tobacco and barley, while the major food crops are rice, wheat, maize, beans, millet and sorghum. Most of these crops are grown under rain fed conditions.

The production of beans in the country is mostly under subsistence farming. According to the 1986/87 and 1987/88 Agricultural Sample Surveys, the areas planted with beans were 160 000 and 197 000 hectares, respectively. Maize crop seems to be the most popular crop, accounting for 38% of the total planted area. According to Due *et al.*, (1985), maize and beans are the predominant crops in Lushoto and Korogwe Districts by small holder families.

Beans are normally grown under inter-cropping system. According to Schwartz and Pastor-Corrales (1989), associated cropping accounts for more than 94 percent in Kagera. Maize/beans is among the commonest mixtures in Tanzania and in other African countries. During inter-cropping, farmers in Tanzania have been seen to grow beans and maize in the same row but different hills, both crops on the same row and sometimes one or more bean rows between two maize rows.

In Mgeta in the Uluguru mountains, the first bean crop is intercropped with maize in November/December and the second crop is monocropped in April/May. In Kilosa district families grow beans both in monoculture and intercropped during the first season and in monoculture in the second season after maize is harvested.

The practice of associated cropping is more common in areas with land shortage due to dense human population. The advantages of associated cropping include; greater productivity, decreased risk of complete failure, decreased severity of disease, production at different times of year, best use of available labour and cash income and balanced diet to the family. However, monoculture is also common in areas where production is more market oriented. Heterogeneous mixtures of different plant types are common in southern Tanzania. The main reason for the practice is the assurance of a more reliable seed yield under low input conditions and a buffer against environmental stress including disease.

In general, the hand hoe is the main tool of production in Tanzania, but in some regions like Dodoma, Singida and Shinyanga a growing number of farmers now use ox-drawn plough. According to MDB (1993), a high return to labour is observed in bean production in many regions due to low usage of modern inputs in comparison to other crops like maize where tractors, pesticide, fertilizer, bags etc are used.

Before trade liberalization, seed production and marketing in Tanzania was the responsibility of Tanzania Seed Company Limited (TANSEED). But recently the maize seed market has been liberalized and some private seed companies have come in eg. the American based CARGIL Hybrid maize seed company. Generally, TANSEED has been concentrating more on maize seed production and very little is done on bean seed. Seed quality enforcement is the responsibility of the Tanzania Official Seed Certification Agency (TOSCA). In 1984-85, some 677 tons of bean seed were produced in the country (Rugambisa, 1990). Although TANSEED does some promotion by radio and posters, seed promotion seems not to be a subject of national policy. For example there are no credit sales and seed prices are prohibitively high. This is so for all crop seed.

2.2.2 Bean Marketing in Tanzania

Generally, bean production in Tanzania is not planned according to markets and demand. Beans that are marketed are also of variable quality. Also due to vagaries of weather and lack of good irrigation facilities, seasonal shortages of beans are common and the result is a varied marketing pattern. This consequently does not support marketing functions like grading and packing (Rugambisa, 1990).

Prices of beans tend to vary with location and seasons but are lowest during peaks of harvesting. According to the MDB Report (1993), a rise in the prices for meat and fish has caused many town residents to opt for beans consumption as an alternative source of proteins. This has brought up an increase in beans demand and put them on the list of agricultural crops which generate cash to farmers in several regions in Tanzania.

Unlike tobacco, sisal, cotton, pyrethrum, coffee and other cash crops, the marketing of beans is not institutionally based *per se*, in the sense that, although there are official organizations like the National Milling Cooperation (NMC) through which beans are supposed to be legally channelled, private traders handle a higher proportion through the open market. The individual businessmen buy beans from farmers in the village and sell them in the urban markets and therefore prices of this crop are mainly determined by forces of demand and supply. Other organizations like NMC are unable to stabilize the prices of beans because the amounts they handle are too small. In many places, these prices are related to types of varieties with the most preferred bidding the highest.

International trade in common bean is relatively unimportant/not widely undertaken in Eastern Africa and the Great Lakes Region because it is a major staple crop and that very little is availabe for export. Besides, there has been a slower production growth in the last decade and population growth has out-stripped bean production. However, there is export potential for green beans especially to western Europe. This is because Western Europe is largely self-sufficient from May to October but during the off-season, beans cannot be grown and have to be imported. Also the increase in European labour costs has caused production to decrease considerably especially for fine and extra fine needle beans (Anon, 1988, cited by Rugambisa, 1990).

The bean market in Tanzania is affected by poor transport and storage facilities. The main transportation constraints include poor roads, inadequate lorries, fuel shortages and lack of spare parts. Also the long distances over which beans have to be transported from production to consuming areas push up the transport cost. The railways network does not adequately serve to transport beans in Tanzania despite the fact that the network is well distributed (i.e from the eastern part of the country to Dar es Salaam (Central line), from the northern Tanzania to Dar es Salaam (Arusha - Tanga line), and from southern Tanzania to Dar es Salaam (Uhuru line also known as TAZARA line (Tanzania and Zambia Railway)), mainly because of the charges. Most farmers cannot afford to pay the cargo hire charges and other fees. Storage technology is inadequately developed, especially at the farm level, where simple and inadequate storage structures, for example, muddy granaries are the norm. Such structures are difficult to clean and are therefore a permanent reservoir of weevils. However, some farmers dry their beans well, which helps to control weevils (Rugambisa, 1990).

Traditional methods to control storage insects include the use of ash or sand to slow the movement of insects by filling inter-granular spaces or coating seeds with vegetable oils. Tobacco leaves or dust mixed with stored beans have been reported to reduce bruchid attack. Chemicals are also used but not affordable to the majority of small holder producers.

2.2.3 Nutrition and Consumption Status of Beans in Tanzania.

The importance of beans in Eastern and Southern Africa is not in doubt, whether as a subsistence food, a small holder farmer cash crop or an inexpensive source of protein for the expanding urban population. Beans are an extremely important source of dietary protein to the majority of people who cannot afford expensive animal protein on daily basis. Beans supply 72% of the dietary protein in Tanzania (Mian, 1977) especially in areas where animal protein is limiting (Smartt, 1976). It is an important food to both urban and rural population. Their importance has greatly increased in recent years (MDB Report, 1993) because of the continuing increases in the price of beef, fish and other animal proteins beyond the reach of most of the Tanzanians. Therefore, Beans are the cheapest source of protein with high content of lysine and tryptophan which supplement cereal and plantain amino acids (Ngowi and Minjas, 1989).

Beans form an important part of the diet for most of the population in Tanzania especially in communities like schools, colleges, army, National Service Camps, prisons and sometimes in hospitals where large quantities of proteins are required per feed. In several places one can also find beans being prepared in burial ceremonies where many people are to be fed at a time. Beans also make an important part of the small restaurants' (locally known as "mama - ntilie" or "mgahawa" which sell cheap foods) menu.

In sub-Saharan Africa, a high proportion of beans is consumed on farm or traded in mainly local markets, which makes it difficult to obtain accurate production and consumption data. In the African Great Lakes Region (Burundi, Rwanda and Zaire) per capita consumption of common bean and their contribution to nutrition is the highest in the World. Average per capita consumption in 1982-84 was 47.7 kg in that area as compared to 19.3 kg in Eastern Africa (Schwartz and Pastor-Corrales, 1989).

Observation from consumer retail markets indicates that bean grains are consumed in both high moisture content (fresh) and dry states. Dry beans can be consumed, boiled alone or mixed with cereal grains, especially maize, sorghum or rice. In some areas beans are also mixed with cooking banana, eg in Kagera and Uganda. Green-shelled beans and tender leaves are also cooked. There are a few bean types which are consumed only in green, unshelled form. Otherwise beans are grown for use as dry seeds mostly because of their longer shelf life. However, consumers are thought to prefer fresh over dry beans because of their taste and shorter cooking time (Personal observation). Also preliminary results from a survey carried out in Uganda by Grisley and Mwesigwa (1990) indicate that producers and consumers have strong preferences for fresh beans.

In sub-Saharan Africa beans are also produced for canning purposes albeit to a small extent. Though at very low rate, Kenya and Tanzania produce seeds for export - eg. about 25 000 ha. are grown on contract to European seed farms by private farmers in

Arusha and Kilimanjaro regions in Tanzania (Rugambisa, 1990). The cultivars are bush types, produced in monoculture and are produced solely for export. These beans also receive inputs such as aerial application of insecticides, not enjoyed by food bean.

2.3 Problems Facing Bean Research in Tanzania

The presence of too many landraces in the country makes it difficult for someone to know exactly the amount of it available in the country, or local cultivars existing. Each location has different varieties with unique factors which makes it very difficult to study, as compared to Europe which has one single pure line (SUA-WSU Bean/CRSP Annual Report, 1994). The whole country has to be covered to study the composition of the varieties and evaluate them for taste and marketability. But this is a very difficult task because even if more effort is used to characterize and store them (varieties), a lot of funds will be needed to facilitate such studies.

The BCMV (Bean Common Mosaic Virus) and halo blight bean diseases which affect bean production in Africa appear to be unique because the diseases are sometimes propagated by alternate hosts during seasons when beans are not grown . This is contrary to what normally happens in other bean producing areas of the world where the bacteria or virus are maintained from one season to the next through bean seed transmissions. As a consequence, different control strategies (apart from resistance) are needed in Tanzania. Such strategies may include alteration of cultural practices to eradicate wild legumes growing in the vicinity of bean fields.

The major problem that affects research which is carried after variety release (eg. cookability, marketing etc) is lack of funds for seed multiplication. Seeds do not reach farmers in time and are not enough.

2.4 Adoption of Agricultural Innovations

As many less developed countries are experiencing rapid rates of population growth, appropriate technological improvements in land-augmenting forms which raise potential land productivity, eg. improved seed, fertilizer and pesticides are important. Appropriate government economic policies and institutions are also considered essential to the success of the selected technological changes (Todaro, 1989).

Many of these countries have put much effort in trying to bring about rapid socio-economic development in the rural areas, through the transformation of the traditional system of agricultural production. This was to be achieved by making farmers adopt modern methods and techniques of agricultural production. But despite several decades of development efforts, the agricultural sectors of most countries in sub-Saharan Africa have shown only marginal improvements (Bernstein *et al.*,1992; Akinola, 1987; and Aikens *et al.*, 1975). Despite numerous so called rural development programmes and projects, farmers in these countries continue to suffer from hunger, poverty and misery. This fact sets up a challenge and need to pre-assess research outputs in terms of their qualities and the expected impacts before delivering them to farmers for adoption. It is also important to understand adoption as a complex phenomenon including the webs of factors influencing it. The sub section below gives a brief review on factors influencing adoption decision and rates.

2.4.1 Factors Influencing Adoption

In the course of performing his/her duties, a farmer has to make numerous decisions relating to both day to day farming activities and long-term farm plans. Some of these decisions could relate to the adoption of specific practices used in the farming operations (Akinola, 1987). Most of the farm level decisions about adoption of improved technology are often governed by socio-economic and demographic factors, as much as they are by ecological and agronomic factors (Polson and Spencer, 1992).

There are numerous factors which may influence a farmer's decision to adopt or reject a particular innovation. These can be classified into five major categories; 1) Farmers characteristics, e.g. age, education and income; 2) Innovation characteristics, e.g. cost, complexity and suitability; 3) Institutional characteristics, e.g. quantity and quality of research and extension services, availability of credit and input supply agencies; 4) Environmental characteristics, e.g. soil types, rainfall patterns and topography; 5) Policy characteristics, e.g. income trade and land tenure systems (Mattee, 1994). These factors tend to vary from one situation to another. However, some of them tend to be influential in many cases as evidenced by the reviewed adoption studies below.

It is possible for researchers to assume that agronomic or specific superior qualities of a technology will be the important influential factors of adoption. For example, it is common for a breeder to assume that a high yielding or a resistance quality will be important in making farmers adopt a particular variety. However true this might be, it is important to note that in some cases the agronomic qualities and performance of improved varieties can be overshadowed by other factors and characteristics of farming households and hence influence adoption. For example, in a study carried by Polson and Spencer (1992) on the adoption of improved cassava varieties in southwestern Nigeria, it was found that socio economic and demographic characteristics of farming households were more important in explaining the adoption behaviour of farmers than the agronomic attributed qualities of the improved cassava. The factors included: the effectiveness of extension services, farm household income, family size, age and education level of the household head, land tenure arrangements and the migrant status of the farming household. Therefore according to Mattee (1994), in this case the important influential factors were mostly related to farmers, institutional and policy characteristics.

The above results are supported by another study carried out in Zambia by Grisley and Shamambo (1993) which analyzed the adoption and diffusion of Carioca beans resulting from an experimental distribution of seed. According to the authors, the bean cultivar Carioca, originally from Brazil, was approved for release in Zambia 1984 after it proved to be high yielding (Bezuneh and Olsen, 1990; Mulenga and Hopkinson, 1987; cited in Grisley and Shamambo, 1993). The agronomic qualities of the cultivar were; acid soils and important viral and fungal disease tolerance, and responsiveness to fertilizer application. The study found that, the most important factors that influenced the adoption of that particular new high yielding bean cultivar were mostly related to farmer's characteristics. The variables for 'farmer's total area in cultivated crops' and 'the area in local maize' were statistically significant and directly associated with an increase in the probability of adopting Carioca. The parameter estimate for the area in local maize was large, indicating a strong association with adoption. Variables indirectly associated with adoption were the level of education of the household head, the average number of years that the field had been in continuous cultivation and the number of cattle owned.

A fertilizer adoption study carried out in Malawi by Green and Ng'ong'ola (1993), showed the importance of factors related to farmers. institutional and policy characteristics on adoption decision and process. In their study, type and patten of farming system, crop variety, access to credit, off-farm employment opportunities and regular labour were established as the main factors influencing fertilizer adoption in less developed countries (arranged here in descending order). This implied that, given the crop variety and farming system, policies that would result in more liberal credit, more off-farm employment and increased regular labour (especially the first two) are likely to increase fertilizer adoption, particularly among subsistence and groundnut farmers, most of whom applied no fertilizer.

Other studies like those done by Schoenmeyer (1977) who compared several innovations which supposedly offered different levels of benefits to farmers, for food as well as cash crops; and the one done by Tilumanywa (1977) who analyzed the adoption of maize and cotton growing packages on communal fields and on individual farmers' fields as well as the one done by Moris (1981) and Moris and Hartfield (1982) on the establishment and achievement of the Maasai Range Project which aimed at modernizing the traditional semi-nomadic production of the Maasai pastoralist by establishing Ranching Associations and proper rotational grazing systems, have shown the influence of factors related to farmers' characteristics in influencing adoption of specific innovations. These innovations were not or only partially adopted due to different factors.

As analyzed by Mattee (1987; 1994), despite the fact that agricultural institutions (including research, extension, credit and marketing institutions) have been mentioned among the reasons for the stagnation of the agricultural sector and that the extension service is ineffective in stimulating farmers to adopt new innovations because of poor training of the extension personnel, there is still a need to look more closely at the institutional factors which hinder or facilitate the adoption of innovations by farmers. In particular, Mattee (1994) stressed that there is a necessity to study more closely the impact of the introduced Farming Systems Research (FSR) approach and the Training and Visit (T and V) system of extension of farmer adoption behaviour. Building on this argument a study on the impacts of the T and V extension system on farmers' knowledge and adoption of technology carried out by Hussain et al., (1994) in Pakistan is reviewed. The study tried to show the effect of extension on the whole process of adoption. It was found that, T and V has increased the quantity but not the quality of extension contact. Extension contact was found to have a significant effect on adoption of chemical weed control, but not on use of new varieties or phosphorous fertilizer. During the period covered in the study by Hussain *et al.*, (1994), chemical weed control was the newest technology and was still at an early stage of adoption, and this might explain the importance of extension contact in the adoption of this technology. Other important variables which were statistically significant in affecting adoption were mostly related to farmers' characteristics eg. farm size, age, and education. Education had a positive impact on adoption of improved varieties and herbicides, emphasizing the role of formal schooling in using new technology. Farm size was found to have an overall positive impact on the adoption of new technology, especially new varieties, possibly reflecting the greater ability (in terms of resources) of large farmers to experiment with new techniques. However, extension radio programmes were found to have no effect on adoption, despite their apparent positive effect on farmers knowledge. Possibly because of lack of practical elaborations and clarification in a dialogue form.

Apart from other influential factors, a given agricultural technology itself embodies a number of important characteristics that may influence adoption decision. Technologies are normally assessed by farmers who are also important sources of technology information and agents of technology transfer. Therefore, as Adesina and Baidu-Forson (1995) argued, farmers are the consumers of the products of agricultural research and their subjective preferences for characteristics of new agricultural technologies are very important determinants of adoption behaviour. Adesina and Zinnah (1993) and Adesina and Baidu-Forson (1995) showed that farmer perceptions of the technology specific attributes of the varieties significantly condition technology adoption decisions. The results of a study carried out in Sierra Leone by Adesina and Zinnah (1993) showed that the omission of such variables in adoption models may bias the results of the factors determining adoption decision of farmers. The above authors insist that farmer perceptions of technology specific characteristics should be considered in evaluating the determinants of adoption decision on agricultural technologies. In investigating the adoption of improved mangrove swamp rice varieties, they used a tobit model[1]. Results showed that the indicators of adoption determinants traditionally used in adoption diffusion studies were found not to be important in deriving adoption decision but the farmers' perceptions of the specific attributes of the varieties. In their model the authors included perception variables like taste, yield performance, easy to cook, easy to thresh and tillering ability, in a binary form basing on whether the farmer found the variety superior or not on the specific qualities.

Another study by Adesina and Baidu-Forson (1995) was done to test the hypothesis that farmer's perception of technology characteristic significantly affect their adoption

[1] A related model i.e. logistic model is employed for some analysis in this study as detailed in chapter three of the thesis.

decisions. Authors used two tobit models for modern sorghum and rice varietal technologies in Burkina Faso and Guinea, respectively, and findings from both models strongly supported the hypothesis. With the dependent variable as the share of the total sorghum and the share of the total mangrove swamp rice area that is cultivated in improved varieties for sorghum and rice models respectively. The independent variables were selected basing on farmer's subjective assessment of yield performance, quality of local porridge made from cassava flour, performance under poor soils, tolerance to striga weed infestation, and drought tolerance in relation to sorghum and rice. These subjective perception variables were defined as dichotomous. Results showed that for both models the farmers' perceptions of four varietal technology characteristics were positively related to the probability of adoption and intensity of cultivation of improved varieties. For the rice model, non of the so-called 'contact' variables were significant in influencing adoption decision.

Farmers ability to read and write, farm size, ability to obtain credit from informal sources and habit of attending society meetings regularly, have been found to have a positive significant effect on the farmers decision to hire tractor services from government Tractor Hire Units (THU), in Nigeria. Conversely, age and size of the labour force who worked regularly for the farmer had a significant but negative effect on the decision (Akinola, 1987).

In Tanzania, several adoption studies have been carried out and different factors associated with adoption or rejection of specific innovations have been identified. The studies are summarized in Table 2.1.

Table 2.1: Summary of studies on adoption of innovations in Tanzania.

Author	Innovation studied	Rate of adoption	Main constraints to adoption
I. Farmer characteristics:			
Schoenmeyer. 1977	Recommended practices for maize and coffee	Partly adopted for coffee, not adopted for maize	Farmers' concern for food security, and food crops being the responsibility of women
Tilumanywa, 1977	Recommended practices for maize and cotton	Maize: more widely adopted on communal plots than on individual plots Cotton: more widely adopted on individual plots than on communal plots	Shortage of labour, and farmers' concern for food security Lack of perceived benefits for maize
Moris, 1981	Commercial ranching	Rejected	Incompatibility with indigenous system
II. Innovation characteristics:			
Keregero *et al.*, 1977	recommended cotton husbandry practices	Some practices adopted, others not adopted	Farmers could not afford the inputs, some practices not compatible to traditional system
Perez, 1987	Recommended cotton husbandry practices	Some practices adopted, others not adopted	Competition with food production, farmers could not afford inputs, and lack of perceived benefits
Sachak. 1977	Introduction of Soya beans	Rejected	Innovation too different and complex, no attractive benefits
Ngasa. 1979	Oxenization	Low adoption	Lack of skills, and interest
Kjaerby, 1983	Oxenization	Low adoption	Lack of cash to buy oxen, cultural and land incompatibility with practices, and poor policies.
Mshana. 1977	Artificial insemination for cattle	Adopted	Lack or cash to purchase services
Mgeni, 1978	Hybrid maize	Adopted	Lack of cash to purchase inputs
III. Institutional factors:			
Hulls, 1971	Recommended cotton husbandry practices	Low adoption	Poor skills of extension staff
IV. Environmental characteristics:			
DeVries, 1976	Hybrid maize	Partial adoption depending on agro-climatic zone	Unsuitability for agro-climatic conditions

Source: Mattee, (1994) pp.169.

2.5 Varietal Qualities Required by Bean Farmers

In most cases, just like consumers of other commodities, farmers' tastes and preferences are vast and variable. Therefore, the subsections below present a review of some of the qualities that seem to be preferred by farmers in relation to bean production, consumption and marketing. According to Due *et al.*, (1985), varieties are generally ranked on the basis of characteristics related to dried beans but little on the basis of leaves or green pods.

2.5.1 Factors Related to Farmer's Preference and Choice in Bean Production

The common bean, *Phaseolus vulgaris* L., is a self - pollinated New World crop which was introduced into Eastern Africa 400 years ago (Edje *et al.*, 1981; Gepts, 1984; cited by Ferguson and Sprecher, 1989). Today beans are grown primarily on small farms where they are a major source of protein in the diet. Through natural and human selection, several hundred landraces varying conspicuously in seed type have been developed, and Eastern Africa has become an important secondary centre of diversity for this crop (Ferguson and Sprecher, 1989).

In Tanzania and other countries, many farmers choose to intercrop beans with other crops and use varietal mixtures of beans as a means of risk management and to fill a range of consumption and marketing needs. Farmers have been found to usually make deliberate decisions about bean varietal combinations and planting arrangements based on their knowledge of the agronomic performance of the varieties available to them (Ferguson and Sprecher, 1989).

Voss (1988) found that farmers in Rwanda often selected mixtures of small-seeded beans to grow on less fertile soils, while mixtures of large-seeded types were reserved for sites with better quality soils. In Malawi where beans are intercropped, farmers normally space beans in relation to maize and to other bean plants to be intercropped with on the basis of growth habit (i.e whether climbing or not), competitiveness and time of maturity of the bean variety (Ferguson, 1987). For example, a climbing bean variety would be cultivated closer to maize plants than for a non climbing variety. Further more, the spacing for non climbing bean variety monocrop is smaller than for climbing variety.

As reported by Ferguson (1987), Research in the Central Region of Malawi indicates that women usually associated a number of traits with each bean variety they grew. That is, bean varieties usually have a number of desirable, and sometimes undesirable, characteristics associated with them. The reasons the women interviewed gave for growing the four varieties sown in large quantities were, in descending order of importance, yield, taste considerations, cooking quality, marketability, date of maturity, health - related issues, insect and disease resistance, and ability to withstand environmental stresses. It is also reported by Due *et al.*, (1985) that most farmers liked to grow the local varieties best as they were readily available in the markets, well adapted to the area, high yielding and insect resistant.

Although yield ranked first in order of importance to the farmers interviewed in the Central Regions of Malawi, three - quarters (3/4) of the reasons for selection of varieties had to do with other factors. In fact, palatability, cooking quality and health concerns accounted for nearly half the responses.

Women reported that differences in taste and texture among varieties provide a welcome change in the diet, and they keep certain bean varieties for their leaves or pods. Cooking time is important to women, especially as firewood becomes more scarce. Women also prefer variations in time to maturity among the varieties to be staggered over the season. Early maturing varieties are particularly important for farmers with very small landholding who run out of food before the next crop is harvested, a situation which is increasingly common in Malawi.

The women interviewed in the study by Ferguson and Sprecher (1989) were also conscious of the value of a genetically diverse stock as a form of food security. They kept numerous beans varieties because, if some failed during the growth season, other would survive to feed their families.

Characteristics desired by farmers in Senegal were found to be early harvest, higher yields. resistance to insects. heat and diseases, taste, colour of grains, and diameter of grain (Bal, 1987 cited in Schwartz *et al.*, 1993). However farmers appreciate having several varieties for different reasons including some varieties with very few desirable characteristics. Studies conducted in Malawi and elsewhere in the region, indicate that farmers are innovators who look out for and are willing to try new crop varieties. This spirit will be encouraged if varieties of their preferred quality are produced.

Small farmers usually obtain bean seed (for planting) from their own stocks (i.e saving from previous harvests), neighbours, through purchase from the local markets/traders or official sources, such as seed companies, ministries of agriculture or extension/development agencies. On most occasions, bean seeds for planting obtained from farmer's personal sources are not enough especially because it is from the same stocks that the household food share is obtained. Therefore, an external source is important. However, if seeds are to come from outside the immediate area, they must be available in good time, affordable and in sufficient quantity. Furthermore, if the bean seeds do not meet consumer requirements in terms of colour, sheen, uniformity, size and cooking time, and if the plant is unsuited to the cropping system, climate, soils and local pests or diseases, it is a total waste of time to try to supply and sell them to farmers. Such diversity of requirements, sets a challenge to seed production systems and in relation to seed quality and provision. Therefore, unless seeds are of the desired quality and distributed on time, farmers will continue to rely on local sources (Griffiths, 1990).

New bean materials introduced by official sources may often require different or modified technologies in terms of input and husbandry. This will delay any beneficial impact. The learning time must not cause investment risk or income decline. Furthermore, if the seed is not comparable to or better than the local bean in appearance and performance, the farmer will not be interested (Griffiths, 1990).

2.5.2 Some Preferred Qualities in Relation to Bean Consumption and Marketing

Consumption and marketing of a product are normally inter-related and tend to influence each other. The two are guided by some preferential qualities of a particular product selected and consumed. Likewise, specific bean varieties must have the qualities preferred by consumers. However, preferences for bean vary; of course, the most preferred for taste will be good for sale as shown in studies carried in Lushoto and

Korogwe by Due *et al.*, (1985). Apart from the specific genetic qualities of a variety other important characteristics for sale includes weight, availability, price and popularity.

Seed Size and Colour

Size and colour are important qualities contributing to appearance of bean seeds (Ferguson and Sprecher, 1989; Grisley and Mwezigwa, 1990; Rugambisa, 1990). According to Schwartz and Pastor - Corrales, (1989), bean consumers generally prefer large seeds. Preferred seed colours are red, red-mottled, purple-mottled or brown-to-light brown mottled. White-seeded beans are preferred for canning. The Canadian wonder seed types are most preferred, while black seeded types have very low preferences. However, the strength of colour and size preferences varies from place to place. For example seed size and colour are less important in places where beans of a variety of colours are grown and where sometimes even mixtures are preferred eg. in Zambia, Burundi and Rwanda. But there is usually a strong market incentive for certain grain colours and types. For example, pure lines receive a market price premium over mixtures of about 20% in Burundi, as much as 100% in Zaire and over 900% in Uganda, where uniformity and the need to meet consumer preferences are of paramount importance (Schwartz and Pastor - Corrales, 1989). However, despite there being a strong market incentive for certain colours, sometimes farmers mix higher priced beans with less preferred types in order to sell their entire produce (Rugambisa, 1990).

On the other hand a study carried out in Uganda by Grisley and Mwezigwa (1990) found that preferences for beans as reflected by consumer prices paid, are a function of taste and that grain size and colour were not strong indicators or proxies of taste.

Cooking Quality and Time

Bean cooking quality is one of the several desirable characteristics which consumers look for. Fast cooking varieties are desirable for domestic and industrial processing. Identification of fast cooking beans is not an easy task for consumers. The decision to purchase a bean lot is based on arbitrary criteria such as source, when they were harvested and vendor's reputation (Maeda, 1990). Farmers in Lushoto and Korogwe districts preferred beans which were soft when cooked or cooked quickly (Due *et al.*, 1985).

Socio-economic studies (Ferguson, 1987; Ferguson and Sprecher 1989) reveal that farmers maintain certain types of beans for short cooking time. Cooking time is important because of shortage of firewood caused by high population density and deforestation for cultivation. Since beans are the major protein source, especially in the Great Lakes and Eastern African regions, the fuel requirement is greater for bean preparation than for other food stuffs in daily diets. Thus, bean cooking time is a major determinant of demand for firewood. There is a need to develop cultivars with seeds of greater protein content and requiring less cooking time. It is also important to relate traditional preparation methods to laboratory determinations of cooking time (Rugambisa, 1990).

Although (fast) cooking quality in bean varieties is a priority to many farmers which requires breeders attention, it is very important to note that there are some other factors which influence bean cooking time/duration. Whereas a fast cooking variety may be developed, such factors may make the variety appear slow cooking. For example, if hard water is used for soaking and cooking the variety will take longer to cook. Studies demonstrate that cooking times increase with degree of water hardness. Hence, widely different cooking times may result from locational differences in water hardness (Hella and Maeda, 1980). This requires a location specific approach in research and breeding strategies.

Hard cooking characteristic can be prevented by harvesting and storage done at appropriate low moisture contents and temperatures. Exposing beans to moist or dry heat immediately after harvest to inactivate enzymes is also a successful technique to reduce the quantity of hard cooking beans. Soaking beans in salt solution is another proposed method to enhance water imbibition and reduce the prevalence of hard cooking beans (Swanson *et al.*, 1985). According to Due *et al.*, (1985), many families do not soak beans before cooking and do not believe that this results in longer periods of cooking. In their study it was found that bean cooked for 2 hours on average.

2.6 Factors Affecting Bean Yield

Yield has always been the most important issue to a farmer. Farmers in Lushoto and Korogwe indicated that they will grow more beans by either increasing number of seasons, expanding farms, or by reducing other crops if bean yield increases (Due *et al.*, 1985). Therefore, high yield is an incentive to crop promotion.

Despite the widespread cultivation of beans, the average yield under the farmer's field conditions in Tanzania has been on the low side, ranging between 200 - 670 kg/ha, whereas yield reported from research stations average 2 tons/hectare (Karel *et al.*, 1980). The available yield data suggest that yield can vary widely over seasons and farms. For example, the data from 1988 and 1989 cropping seasons (Mkuchu and

Myona, 1989) show wide fluctuations between seasons as well as among farms particularly in areas with unpredictable rainfall such as Morogoro.

Low yields of common beans in Tanzania have been attributed to a number of factors including poor agronomic practices, drought, weeds, diseases, insect attack and socio-economic factors (Rweyemamu, 1989). For Example, in Southern highlands the poor maize crop performance has been associated with the use of low yielding, diseases and pest susceptible varieties (Mkuchu and Myona, 1989).

Results of farmer interviewes by Due *et al.*, (1985) conducted in Lushoto district indicated that bean yields were affected by too little early rain, too much rain, poor soil, hot temperature, animals, cold weather, diseases and insects (eg. bean flies, aphids and bean mites) and unavailability of farm inputs. This emphasized the need for high yielding, insect , diseases and drought resistant varieties.

Diseases are among the major factors limiting yields in most bean growing areas (Rweyemamu, 1989; and Due *et al.*, 1985). The most predominant diseases in all bean producing zones are Anthracnose (*Collectotrichurium linde mun thianum),* Angular leafspot *(Phaesoriopsis griseola)*, Rust (Uromyces appendiculatus), Bacterial blights (*Pseudomonas phaseolicola*), *Xanthomonas campestris* pv *phaseoli* and *X. Campestris* pv *fuscans*, Root rot (Fusarium solani F. sp. phasedi) and common bean mosaic virus. Alone or in combination these diseases have been associated with large proportions of crop losses, either directly by reducing quantity or indirectly by increasing costs of production (Shao, 1981). Proposed methods for disease control include; the use of chemicals. however, these are expensive and hence unaffordable to most farmers (Wolf and Barnet. 1980); the use of resistant varieties although resistance towards specific diseases tend to decline with time; and the use of cultivar mixtures which controls air borne diseases (Burdon, 1978).

Various constraints accounting for low bean production in Tanzania are: unreliable rainfall which is often times sporadic and poorly distributed, use of unimproved low yielding cultivars which are susceptible to pests and diseases, input unavailability, poor transportation, and poor marketing facilities (Karel *et al.*, 1981; Hamis *et al.*, 1985; Kwimbere and Mbiha, 1985). Soil fertility also plays an important role in influencing yield performance in some parts of Tanzania.

Poor Marketing system and facilities in the country also affect bean production performance because farmers need to sell part of the harvests to obtain cash to cover both family demands as well as next season's production costs. Farmers are used to selling part of their crops in different markets for different reasons. However, reasons of choice for market is mostly based on price and convenience. Major marketing problems as discussed by Rugambisa (1990) include, lack of transport and low prices. Price is very vital in bean crop promotion because as reported by farmers in Lushoto and Korogwe, farmers will grow more beans if prices increases. However, when price falls, the same amount of beans may still be produced because of the necessity to maintain food security (Due *et al.*, 1985).

Poor storage facilities at a household level also affect bean production because most farmers rely on saving previous harvests or buying from local markets for bean seeds for planting. Therefore, if storage facilities are poor the viability of the stored seeds is reduced or destroyed. The majority of farmers store previously sun - dried beans in bags. Storage insects and other pests problem has been observed by many farmers in Lushoto and Korogwe. The use of chemicals to spray beans is not sustainable in Tanzania because the chemicals are highly expensive and hence not affordable to majority. On the other hand, some farmers believe that the use of chemicals reduces germination (Due *et al.*, 1985).

2.7 Impact Assessment

Research impact is usually recognized when varieties or new agronomic techniques that have the potential to increase yield are adopted by farmers, resulting in increased production and/or lower costs (Oehemke *et al.*, 1992). In summary, impact assessment shows the difference between the "with" and "without" the project situation.

Bernstein *et al.*, (1992), points out that for there to be an impact; (1) Projects must have developed and released technologies that have been adopted by producers/consumers; (2) Adoption of these technologies must have resulted in an improvement that can be measured/quantified; (3) Data collected to demonstrate impact must be collected over a sufficiently wide area (and from the diverse groups in the area) to show that the impact is not site/group specific, but rather widespread - both in terms of area and types of beneficiaries (i.e, male, female farmers, rich/poor consumers).

Impacts of agricultural research are commonly judged on both economic and social grounds. The rate of return to agricultural research investments is an estimate of the level of economic benefits generated, above and beyond the cost of research. Conceptually, the rate of return is roughly equivalent to the interest rate which a bank would have to pay to generate the same net returns as was generated by the project, if the research funds were invested instead in a bank. All rate of return methods require detailed data on research costs and benefits (Bernstein *et al.*, 1992). Social impacts are estimated by levels of factors like adoption rate, characteristics of adopters *vis-a-vis* non-adopters in relation to access to inputs, marketing services, extension and related factors.

Farm level impacts

The key to economic, social, and environmental benefits from research investments is to design technologies farmers choose to adopt. Farmers decisions to adopt new technology bring impacts at the farm household level, on family income and welfare and on the physical and human resources used in farming. Economic repercussions extend beyond the farm, through the markets that receive the increase in production and supply the new fertilizers, herbicides, and pesticides, if the scale of production is broad enough, these repercussions are felt in the regional, national, and even the global economies (Collinson and Tollens, 1994).

Farm level impacts of technology may include; the value inputs served through more efficient production techniques (lower cost production); yield gains from a new variety or value of the increased production through the use of a new technology; improved farm income from product sales; stable production resulting from eg resistant/tolerant variety; good quality product eg. large seeds, palatable variety; improved nutritional status; contribution of improved seed to household grain supply or increased grain diversity: and early maturity gains (Collinson and Tollens, 1994; ICRISAT, 1993).

2.8 Measuring Economic Impact

In measuring impacts, the methodologies can broadly be classified into *ex-ante*, versus *ex-post* and efficiency versus effectiveness analysis. Impact assessment before execution of the research programme (*Ex-ante* impact analysis) is mainly for planning, priority setting and resource allocation. *Ex-post* impact analysis is done after the programme. Adoption studies are done as part of technology transfer and diffusion. The *ex-post* analysis is mainly concerned with accountability and establishing credibility of public sector or donor funded research. It helps to justify continued or increased funding for some programmes.

Norton and Davis (1981), point out that since there is no single approach which is superior in all situations in research impact assessment, it is useful to compare approaches, drawing conclusions about their strengths, weaknesses, and ability to answer different questions. They thus provided a guide in comparing different methodologies. Senkondo and Temu (1994), concluded that *Ex-post* measures of research impact analysis are much more relevant for the bean research project. The above authors add that methods selected need to take cognisance of; (1) the initial objectives of the bean programme; (2) impact of introduced bean variety on yield (in sole and inter-cropped form); (3) impacts on nutrition to the end users; (4) broader impacts on society, economy, environment and institutions; and (5) the cost element of the methods selected (ie. in terms of time and resources required).

Available econometric methods for assessing the impacts of highly complementary investments require high quality time-series data, and therefore are not usually feasible in data-poor developing countries. Unfortunately, research programme evaluations that do not provide information about the role and sequencing of investments in critical complementary organizations can overestimate the impact of particular investments (Howard *et al.*, 1993). Further details on *ex-ante* and *ex-post* methodologies are presented in the subsection below.

2.8.1 *Ex-ante* Methods

These can be classified into four groups (Norton and Davis, 1981), (i) those using scoring models to rank activities; (2) those employing *ex-ante* cost benefit analysis; (3) those using simulation models and (4) those using mathematical programming to select an optimal mix of research activities.

These methods are discussed in detail in Norton and Davis (1981) and are not presented here. As mentioned earlier, impact assessment for SUA Bean CRSP requires mostly the *ex-post* methods because the project has already been in existence for sometime.

2.8.2 *Ex-Post* Methodologies

A comprehensive review of both macro and micro level studies evaluating returns to agricultural research is contained in Norton and Davis (1981). While there is a wide application of research impact methodologies world wide, the attempts so far made in Sub-Saharan Africa are affected by lack of useful data and especially *ex-ante* data (ie.

baseline data or data before the commencement of the research) (Anandajayasekeram *et al.*, 1996).

Ex post evaluations fall into two major groups: (a) those using consumer and producer surplus directly and estimating an average rate of return to research (surplus approach), and (b) those estiamting a marginal rate of return to research by treating research as a production function variable (Econometric approach). In addition, there are two major studies outside these two classes: one estiamtes the impact of technology on national income and the other measures the nutritional impact of agricultural research. (Norton and Davis, 1981).

Kupfuma (1994), examined the role of research and extension in improving the productivity of maize in Zimbabwe from 1932 to 1990. Kupfuma evaluated the pay offs to research and extension investments and analyzed the institutional environment under which technology generation and transfer occurred. He used the Akino-Hayami pivotal shift of the supply curve. The rate of returns to maize research and extension was estimated as 43.5% which was almost three times the rate of returns to capital investments in the private sector. Institutional analysis revealed that the productivity of the maize research team was made possible through the provision of adequate research budgets, low staff turn over and attractive salaries in good working environment. However, the study did not pay any explicit attention on the impact of maize research on the environment.

An *ex-post* evaluation using a Production Function Model was used by Karanja (1993), to measure the impact of maize research in Kenya. This methodology enabled the isolation of the effect of maize research on overall growth of maize production in Kenya because the success of maize in Kenya is commonly attributed to maize research, agricultural extension and seed development programmes. The study focused on the productivity of the research component. Time series data for the period 1955-1988, which coincided with the era of the inception of the maize improvement programme, was used for the analysis.

A number of regression equations was used in the study and the choice of variables used to formulate the equation(s) was governed by, first a basic understanding of those factors that would have contributed to growth in maize productivity and, secondly, availability of data and the ease of collecting it. *A priori* expectation on the functional relationships existing between maize output and these explanatory factors was an important guide to the analysis. However, lack of adequate farm level data, which would have been ideal in measuring research impact, hindered achievement of a perfect output-input relationship model.

The output was represented by the value of total production calculated using deflated prices. However, yield and area variables were preferred as the dependent variables. From his analysis which was governed by several assumptions, estimates of the Rate of Return (ROR) was on average greater than 40%.

Howard *et al.*, (1993), assessed the impact of investments in maize research and dissemination in Zambia. They used the Cost Benefit Analysis (CBA) methods and the Akino-Hayami methods in calculating average return to research. Two time periods were used ie. 1978-1991 and 1998-2001 (projected). The study emphasized that there was a need for including contributions of non-research organizations to the technology process, e.g also including some assessment of impact of agricultural marketing, seed industry or any other complementary organization.

2.9 Measuring Social-Cultural Impact

The social effects of agricultural research can be measured through social impact analysis. Social impact analysis moves beyond measuring the extent of adoption of new technologies and rate of return to consider the characteristics of adopters vs non-adopters with respect to factors such as labour availability, farm size, gender, access to credit, extension, and marketing services. A primary issue of social impact or distributional analysis is to determine who has benefitted from the research; i.e large or small - scale farmer, women or men, rich or poor or middle class consumers. It is worth noting that, because in many areas of the world, beans and cowpeas are traditionally grown by women and because women are the ones primarily involved in processing and marketing of these legumes, a gender biased kind of approach can be applied (Bernstein *et al.*, 1992).

According to Anandajayasekeram and Martella (1996), an R&D activity is considered to result in a social impact if the activity contributes to a change in the well being, i.e., in ways other than changes in income, in the target population. Socio-cultural impact of agricultural technological innovations may include improvements in income distribution between genders, income groups, locations, institutional and infrastructural implications, effect on the nutritional status, changes in resource use patterns, etc. According to the authors the most obvious method for assessing socio-cultural impact is the socio-economic survey, and to be cost-effective, such questions be included with the adoption survey. A baseline survey and continuous monitorign of farm households, also facilitates such assessments. It is worth noting that, because of lack of adequate baseline data on bean production in Tanzania, this study relies on cross-sectional survey data in conducting a limited amount of economic and social impacts analysis.

2.10 Measuring Farm Level Impacts

Measures of farm level impacts starts from counting adopter farmers who use the technology. For example, a CIMMYT on-farm research project on maize in Panama focused on the maize/bean rotation system. After four years, 61 percent of farmers had adopted improved weed control, and 43 percent had adopted some form of reduced tillage; 35 percent had adopted improved varieties by 1985 and 74 percent by 1989, and the use of row planting had increased from 30 to 80 percent (CIAT, CIMMYT, and CIP, 1992). In this study, adoption was used as a measure of success, and researchers assumed that farmers adopted the new varieties and techniques because they brought benefits.

Historically, much impact assessment has been based on measuring the changes in the productivity of the crop or animal enterprise using the new technology. This approach requires more than simply identifying adopters (Collinson and Tollens, 1994). Extra data might include: The land area or number of animals to which the new technology is applied; the yield increment to the technology; increased stability of yield over time and reduction of risks; the cost reduction achieved when lower costs are the source of benefits; the net benefits obtained (the value of the incremental yield less the costs of obtaining it); and the contribution of each component of the technology (the variety and each new management practice) to the yield increment and sometimes to the net benefits obtained.

CIAT and NARS in Colombia and Venezuela implemented an integrated pest management program for rice, based on economic thresholds, which illustrates both cost reduction and environmental impact as sources of benefits. In colombia, the total insecticide and fungicide applications were reduced from nine per crop cycle in 1980 to three 1990. In Venezuela, monitoring began in 1988 when more than 60 percent of farmers made two or more applications: by 1990, more than 90 percent were making one application at most (CIAT, CIMMYT, 1992).

2.11 Measuring Adoption and Diffusion of Technology

Different models have been used to study and explain the determinants of innovation diffusion and adoption. This begins from the early work by Rogers (1962). Three groups of paradigms for explaining adoption decisions can be found in the literature:

The first group is the innovation - diffusion model which explains that access to information about an innovation is the key factor determining adoption decision (for a good review of this issue see Agrawal, 1983). According to Adesina and Zinnah (1993). the appropriateness of the innovation is taken as given, and the problem of technology adoption is reduced to communicating information on the technology to the potential end users. That by emphasizing the use of extension, media, local opinion leaders or through visits to experimental stations and on farm trials, the sceptic non - adopters can be shown that it is rational to adopt.

The second group is the economic constraints model (Aikens *et al.*, 1975) which contends that economic constraints reflected in asymmetrical distribution patterns of resource endowments are the major determinants of observed adoption behaviour. Lack of inputs like capital or land could significantly constrain adoption decisions (Haves and Flinn, 1976; Yapa and Mayfield, 1978; cited in Adesina and Zinnah, 1993).

The third paradigm, which has evolved recently is called the adopter-perceptions model (Adesina and Zinnah, 1993; Adesina and Baidu-Forson, 1995). The concept, which is now being implicitly used in one form or the other in agricultural economics literature (Gould *et al.*, 1989; Norris and Batie, 1987), suggests that the perceived attributes of innovations condition adoption behaviour. A perception variable measuring farmer's perception of a problem e.g. soil erosion (Gould *et al.*, 1989; Norris and Batie, 1987), and variables measuring farmers subjective preferences for technology characteristics eg. taste, cooking time, threshing (Adesina and Zinnah, 1993; and Adesina and Baidu-Forson, 1995) have been included in adoption models. The paradigm explains that adoption or rejection of technologies by farmers may reflect rational decision making based upon farmers' perceptions of the appropriateness (inappropriateness) of the characteristics of the technologies under investigation.

Behavioural models or qualitative response models as discussed in Amemiya (1981) have widely been used in empirical adoption analyses. These models (eg. the tobit or logistic models) are also known as binary or discrete or dichotomous models. In specifying a binary adoption decision models, a random variable takes a value of 1 if the event occurs and 0 otherwise. Qualitative choice models are important in analyzing relationships involving a discrete dependent variable. In such relationships, the probability of an event occurring is a function of a set of non-stochastic explanatory variables and a vector of unknown parameters (Polson and Spencer, 1992).

These models have been found useful in adoption studies because the decision is to adopt or not to adopt, and their applications in explaining socioeconomic phenomena are not new (some examples are Debertin *et al.*, 1980; Lee and Stewart, 1983; Capps and Kramer, 1985). Some few studies which have relied on the dichotomous models are reviewed below;

Akinola (1987) applied a probit analysis of the adoption of tractor hiring service scheme in Nigeria. In his model, the dependent variable took a value of 1 if the farmer hired tractor services from the government Tractor Hire Unit (THU) in 1984 and 0 otherwise. A set of selected explanatory variables expected to influence farmers' decision about whether or not to hire tractor services was also used. Results were estimated by maximum likelihood method and the coefficient of all except one variable were statistically significant at 5 percent and the *a priori* hypothesis was supported.

In a study carried by Polson and Spencer (1992) on adoption of improved cassava varieties in Nigeria, both probit and logit models were specified. The dependent variable adoption, and the independent variables farm size, age, land ownership migration status of the household head and extension contact were binary while family size and average household farm size were continuous. The model facilitated the identification of factors that influenced adoption of the cassava varieties as well as to compare the adoption intensity between migrant farmers and indigenous farmers.

Adesina *et al.* (1993; 1995) used tobit models to assess the effect of farmer's perception on adoption decision. In the model specification, a binary dependent variable, adoption, was assumed to be influenced by a set of two classes of explanatory variables. The first class (i.e technology perceptions) were farmer's subjective assessments of qualities like, yield performance, ease of cooking, tillering capacity, and ease of threshing. The inclusion of these variables allowed the measurement of the probability that the technology will be adopted as well as the use intensity of the technology once adopted. The second set included other socio-economic and demographic characteristics of farm households like age, income, extension contacts and farm size.

Grisley and Shamambo (1993) made a study on the adoption and diffusion of Carioca beans in Zambia where a new high yielding bean seed cultivar Carioca was distributed directly to 400 farmers during 1986. The household sample was selected in a non-random fashion and after three seasons interviews were carried out. In their analysis, tabular correlation methods were used to identify the characteristics of the households and farms studied and the extent of adoption and diffusion of the new cultivar. Regression methods were used to investigate the determinants of adoption by 1988/89. Because the adoption decision examined was categorical, either to adopt or not to adopt, a logistic model was used for the analysis. A logistic model is used in this study to investigate some adoption factors as detailed in chapter three of the thesis.

The above authors suggest that for self-pollinated crops like beans, whose seed multiplication rate is slow relative to that of other crops, selecting the appropriate group of households to disseminate seed can be important. The results reported in Grisley and

Shamambo (1993), show that the determinants of adoption can be identified using simple and well known modelling methods.

An empirical analysis of farmer-to-farmer transfer of new crop varieties on small farms in Uganda was done by Grisley (1994). In the analysis, farmers' decision to transfer grain to other farmers was viewed in a binary mode. In investigating this situation a logistic modelling framework was used. Using this model, factors associated with the farmer's adoption decision were isolated. Among his several findings, Grisley (1994), found that the quantity of grain available was not associated with the decision to transfer but had more to do with other factors such as characteristics of the farmer and his/her social position.

The reviewed literature and methods of impact assessment and adoption (of technologies) have saved as a guide in the development of the study methodology of this study (as explained in the next chapter), and in discussing and designing conclusions of the study (in chapters four and five of the thesis).

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter describes the study methodology. It begins with a brief description of the study area and the Tanzania Bean CRSP Project including a review of the technologies developed so far. Data collection process, the questionnaire and the analytical tools including their conceptual framework and equations are also covered. The chapter ends with a short discussion of the data limitations faced by the study.

3.2 Description of the Study Area

The farm level impact assessment study of the Tanzania Bean CRSP Project technologies was done in Morogoro region. The study concentrated on two districts; Kilosa and Morogoro Rural. The selection of sites was made by considering the bean production potential, climatic differences including altitude with respect to farming systems as well as accessibility to the areas.

In Kilosa district rains begin in November and continue until May. There are two rainy seasons. The short rains fall between October and early February with the average of 431 mm, the long rains usually begin by mid February and continues until May with an average of 608 mm (estimates from 1980-1990 data). Beans are normally planted a few weeks after the long rains thus avoiding heavy rainfall. Not all areas in this district are suitable for a second bean crop. As for the villages in the sample, Kisanga and Msolwa villages were found to plant beans in both seasons. The rains are unpredictable with the short rains being less reliable than the long rains. There is usually a short drought of two to three weeks between seasons. The Morogoro Rural District which is on the east of Uluguru mountains, has two rainy seasons which are separated by a variable short dry spell from late January to late February. The first rainy season starts in November and ends in December or early January. The long rain season starts in March and runs to May. The rainfall distribution is uneven. Beans cropping is mainly done towards the end of the long rains although some few bean crops are produced during the short rains.

The annual average temperature in Kilosa ranges from 18^{0}C to 30^{0}C with a mean temperature of about 22^{0}C. Morogoro Rural district has an annual average temperature of 24^{0}C in low altitudes and 14.5^{0}C in higher altitude areas.

Four main groups of soils have been found in Morogoro rural district. They are dry slightly clay soils, red soils, alluvial soils and soil partly overlaid with alluvium. On average, soils are basically of sandy texture with some patches of red to black soil. In the higher altitudes, brownish red rather than sandy soils with friable clay is found. However in some parts of the district, the soils are rich in nutrients which are associated with higher organic carbon due to greater amount of litter fall in the wetter climate. In Kilosa district, especially in Dumila and Magole, the soils range from black to red clay and include sandy loam types. But in river valleys where most crops are grown, and parts of Kisanga and Msolwa villages the soils are rich in nutrients due to flood deposition from other place. It is important to note that Kisanga and Msolwa villages are not traditional but recently established villages by people who have migrated from other villages and from other regions, mainly from Tanga and Iringa. The villages are surrounded by a range of mountains and two rivers and therefore making it a fertile plain which receives rain-washed nutrients from other places.

Forests are found on the higher altitudes of Morogoro Rural district and occupy a reasonable large area. The wood land is comprised of several types of which the mixed Miombo wood land is predominant. Wooded grassland on the other hand includes grassland and herbs mixed together. Bushes and scattered trees of below 200 metres high also exist. The forests found in Kilosa are woodland comprised of the Miombo woodland and acacia trees. The woodland grassland includes grasses with herbs and scattered bushes.

The principal cropping systems of the areas of study and other areas of Kilosa and Morogoro district can be classified into three categories; mixed cropping system, traditional cropping system and vegetable gardening system. The commonest system is the traditional cropping system which constitutes the cultivation of traditional crops which include maize, beans and garden peas. At low altitudes crops like sweet potatoes, cassava and pigeon peas, are dominant. These crops provide staple diet within the areas. Other crops which are grown as traditional crops include coconuts, banana, yams and fruits such as citrus fruits and mango. These crops are usually intercropped and occupy plots some how distant from the houses. The livestock production is not much commonly practised in the areas.

At present land is considered as a less limiting factor in crop production in all areas, but there is a danger for it to become a strong limiting factor in future due to increase in population especially in Morogoro Rural district (Mwakalobo, 1995). Despite the fact that land is considered as public property i.e land is not in general privately owned in Tanzania. Most of the farmers have more than one plot scattered in different sites around the village. This has resulted in a lot of time wastage in crop to and from the far away plots.

The majority of farmers experience peak labour demand almost simultaneously especially during weeding and land preparations. During these periods hired labour is also in short supply and expensive (personal observation). Normally hired labour is used for land preparation and harvesting. Overall, family labour is the most important source of labour in all areas.

3.3 The Tanzania Bean CRSP Project

The Collaborative Research Support Programmes (CRSPs) are communities of US Universities, US Agency for International Development (USAID) and USAID Missions, and developing countries national agriculture research systems (NARs), other US federal agencies, International Agricultural Research Centers (IARCs), private agencies, industries, private voluntary organization (PVOs), and other developing country institutions. Their scientists, in close collaboration with one another and for the mutual benefits of their programmes, carry out agricultural research and training around identified constraints of food production, storage, marketing, and consumption. Through shared resources, peer review and institutional support, these communities of scientists and institutions give emphasis to the needs of small scale producers and the rural and urban poor.

The Tanzania Bean CRSP Project (Sometimes referred to as SUA Bean CRSP Project) is among the CRSP projects. The project operates under the auspices of Bean/Cowpea CRSP. It was launched in 1982 here in Tanzania and implemented in collaboration with the Washington State University in US. Overtime, and as reported in Silbernagel (1985), the project has strived to develop beans that are resistant to major diseases and insects, high yielding beans which cook quickly and which can fix own atmospheric nitrogen. The overall aim of the project was to improve the well being of the small holder farmers through contributing to increased bean yield, profitability and consumption.

3.3.1 Tanzania Bean CRSP Project's Activities

Since its establishment in 1982, the Bean Improvement Programme has been making plant selections from segregating materials and evaluating local cultivars for high grain yield, resistance to diseases and pests as well as for suitable agronomic characters. The project research has resulted in three technologies i.e NITROSUA and two cultivars/advanced lines: SUA 90 and EP4-4. The two are resistant to BCMV, Rust, Halo Blight and Common Bacterial Blight; tolerant to drought and Angular Leaf Spot; fast-cooking and liked by consumers for their "sweet" taste. The red colour of EP4-4 is particularly popular (SUA-WSU Bean/CRSP Annual Report, 1994).

The project has also been involved in germplasm collection and testing of appropriate agronomic practices for bean cultivation. Such information has been disseminated through workshops, seminars, published papers, on farm trials and participatory research activities. Furthermore, the statistics released by the Tanzania Marketing

Development Bureau show that a yield increase from 503,200 to 1206,500 tones in 1988-89 and 1992-93, respectively, was produced in the Morogoro region. This indicates a doubling of bean production in the Morogoro region where the SUA Bean CRSP has focused one-third of its activities since 1982.

In addressing storage problems, natural products and synthetic insecticide have been tested for control of bean insect pests. Natural extracts, particularly hot pepper and cowdung, reduced the incidence and damage caused by foliar beetles, bean steam maggots, flower thrips and pod borers. Generally, the control was pest specific. The individual SUA Bean CRSP technologies are discussed in the sub sections below.

SUA 90 bean variety

According to the project's annual report of 1994, the SUA 90 bean variety was released in 1990. SUA 90 variety is a bush type bean plant that grows to a height of between 42 and 46 centimeters and pinkish white flowers. It flowers between 30 and 32 days after planting and reaches maturity as early as between 60 and 62 days after planting. The variety is high yielding with a potential yield of between 1,800 and 3,000 kilograms per hectare, a figure that is higher than the below 500 kilograms for other local varieties like Canadian Wonder, Kabanima, Kablanketi etc. that are used in the country. The bean has medium khaki seeds weighing 21 grams per 100 seeds and is ideal for low areas up to 1,000 meters above sea level. The recommended planting seed is 65 to 70 kg per ha. The 1994 SUA Bean CRSP report explains that good performance of the variety has been reported from such places as Moshi and Lushoto. The variety responds to the following small holder farmer problems: unavailability and high cost of insecticides and fungicides, drought, diseases, fuel shortage and women excessive labour. Involvement of small holder farmers, some of whom are women, in the breeding programme ensures acceptability of released varieties.

According to the SUA-WSU Bean CRSP Annual Report (1994), from 1990, small amounts of SUA 90 seeds were distributed to farmers in Morogoro region every year. Between 1991-94 approximately 90 farmers received SUA 90 seed in the Morogoro, Arusha, Mwanza and Kilimanjaro regions to grow in their own fields. According to the same report, many farmers in the Morogoro area and beyond gained interest in the seed and indicated they would like to grow more of SUA 90 if seeds were available. SUA 90 seed has been found in several small markets (eg. Kididimo and Matombo) in the Morogoro area. Basing on the same report, it is estimated that over 300 kg of this seed have been shared informally between farmers.

With emphasis on Morogoro region, this study aims at assessing the adoption process of the introduced technologies. To increase coverage and intensity of the study within Morogoro region, SUA 90 seed variety was distributed to over 200 farmers in some selected villages in Morogoro rural and Kilosa districts in the 1994/95 season. These farmers together with those who initially received the seed were interviewed after the 1994/95 and 1995/96 seasons. For the purpose of generating comparative data some farmers not growing the SUA 90 bean variety but farming in the same domains were also interviewed.

With reference to consumption SUA 90 variety is merited for its fast cooking characteristics, less fuel energy consumption and good taste. The variety is also known to be containing a less amount of anti-nutritional factor i.e. tannin and trypsin inhibitors which make beans digestion a problem thus accumulating gas in the stomach.

EP4-4 Bean Variety

EP4-4 bean variety is undergoing the final stage for release. Performance data for EP4-4 was compiled and submitted for presentation to seed release committee in December, 1994. The first seed from EP4-4 was distributed to a women's group for planting during the 1994 short rain season (i.e October). The variety has been tested in farmers' fields in Kilosa and Morogoro districts for yield, cookability, disease reaction, moisture stress tolerance and palatability. The evaluation results indicate that EP4-4 is superior to local varieties in terms of the above mentioned qualities.

NITROSUA Technology

The SUA-WSU Bean/CRSP Annual Report for Financial Year 1994, shows that NITROSUA is a recognized SUA Bean CRSP technology which increase soil nitrogen when added on a one-time pre-planting basis. Compared to chemical fertilizer, it is more cost-efficient and environmentally sustainable. Since 1991, a total of 152 farmers have received NITROSUA. It was estimated that 333 kg. of NITROSUA have been used on 555 acres of beans. To each farmer receiving NITROSUA, this represents a saving of $ 89 each, or a total saving of almost $14,000 annually when compared to the cost of purchased artificial fertilizer. NITROSUA responds to the following problems of small holder farmers: low soil nitrogen, need for artificial fertilizer, high cost and limited availability of inputs, and soil acidity.

Farmer Participatory Research

Farmer participatory research (FPR) was incorporated in the SUA Bean/CRSP in 1990 with the following objectives; (1) to improve farmer/consumer evaluation strategies to ensure that users' preferences are incorporated into breeders' decisions (primary); (2) to continue farmer evaluation for improved bean lines (primary); (3) to compare farmers' evaluations of early generation materials with scientists evaluations of early generation materials (primary); (4) to collaborate with socio-economic personnel to develop plan for assessing impacts of cultivars to be released to small holder farmers (primary). (5) to complete FPR video for biological scientists (secondary).

The Tanzania Bean CRSP Project has been conducting bean crop trials and evaluations in Kilosa and Morogoro Rural districts. SUA 90 bean variety and other technologies have been tested in the farmers' fields. Farmer participatory research has also been carried out in some of the villages in Kilosa and Morogoro districts. Farmers have often been called for on station plant evaluations and their preferences have continuously been incorporated in the project's breeding programmes. For a detailed description of farmer participation in bean breeding/selection at SUA see Butler *et al.* (1995) and Kashuliza *et al.* (1996). Several other projects can be found in the districts including horticultural products development projects (UMADEP and UMHODEP), rural fish farming development programmes done by UNDP, promotion of cooperative unions and banking activities, only to mention a few. Therefore, farmers in the sample areas have considerable experience of working with research and development projects.

3.4 Farmer Sample and Location

A sample of 277 farmers were formally interviewed for this study. One hundred and seventy two (172) farmers out of the sample were farmers who received and cultivated SUA 90 bean variety over the period of 1990 to 1994 and during the 1994/95 and 1995/96 seasons. For the purpose of obtaining comparative data 105 farmers who have not grown SUA 90 variety before, but grow other varieties of beans and reside in the same villages as the main sample, were also interviewed (as a control group) because selecting SUA 90 growers alone would have biased the sample and assumed that non growers have a zero demand for the innovation (Akinola, 1987). Based on the argument put forward by Polson and Spencer (1992), it was considered more reasonable to assume that the non SUA 90 bean variety growers exhibited market behaviour in not growing the variety by influencing the bean market share. By not growing SUA 90 bean variety there is a possibility that the non SUA 90 growers consumed more seeds of other bean varieties and hence reduced the market share for the SUA 90 growers, as a result more SUA 90 seeds were consumed by the SUA 90 growers. On the other hand, the non SUA 90 growers might have influenced the adoption process by advising each other especially because they were eager to check on the knew innovation which they did not happen to have by that time.

The interviews were conducted in seven villages located in Morogoro rural and Kilosa district where most of the SUA 90 bean variety has bean grown. The villages are Kinole, Mgeta (Morogoro rural district), and Dumila, Magole, Ulaya-Mbuyuni, Kisanga, Msolwa (Kilosa district). The sample of farmers across the villages of study was variable and was determined by the number of farmers who received the SUA 90 bean variety seeds and other bean growers (randomly selected) and who were available for the interviews.

The Sampling Procedure

The district and villages were selected based on the observed and previously known bean production potential. Bean farmers known by the village extension officers made the sampling frame. Village extension officers in the sample villages were asked to list all the bean farmers in their villages and the sample members were then picked from the list at random by the researcher. About 300 bean farmers were selected (but only 277 were available for interview) and the selection was done in such a way that the ratio of men and women was at 50%. Two hundred farmers out of the 300 were given SUA 90 seeds during the 1994 crop season (the target group). and the rest (100) were left as a control group.

3.5 Data Collection and the Questionnaire

The main source of primary data for this study was the small holder bean growers in the villages indicated. Information from the farmers was collected through interviews using two structured questionnaires. The questionnaires were designed to capture both qualitative and quantitative data useful for the study including information on age, gender. crop types grown. yield. bean characteristics, income levels, consumption of different bean varieties. problems facing bean production. farmer to farmer seed distribution. price of beans, adoption and amount of seed planted, sold and consumed.

The first questionnaire was the major one which collected information about farmer's general information, bean and other crops production, bean production problems, bean consumption characteristics, bean marketing and storage issues, comments in relation to positive and negative qualities of SUA 90 bean variety and adoption potential of the SUA Bean Project technologies. The second questionnaire mainly aimed at capturing information on bean seed adoption, diffusion and the extent of farmer to farmer transfer of seed. The study questionnaires appear in Appendices A and B.

The study also made use of data and information collected from secondary sources including SUA Bean Project documents and proceedings. Additional information for the study was collected through informal discussions with individuals and groups of farmers (especially women), extension officers and village leaders in the villages selected for the study.

The interviews were carried out in two phases. The first phase took place between January and June 1996 using the main questionnaire following the 1994/95 growing season. Second phase interviews were carried out between August and September 1996 after the 1995/96 season. Data from the second phase interviews were mainly used to strengthen the adoption model by allowing a third growing season (i.e to document the numbers and reasons of farmers in replanting SUA 90 variety for the third season). The first season was considered as an introduction period where the innovation was delivered to farmers. The second season allowed time for farmers to make evaluations. Therefore, it was assumed that during the third crop season farmers would have been in the adoption process. It was expected that after the 1994/95 harvests, more farmers would have learnt about the variety and that they would access seed from their normal sources including fellow farmers and market. As for the second phase, only 172 farmers who received seed from the 1994 distribution were interviewed. This had a purpose of allowing equal number of seasons for all the respondents in the adoption model.

3.6 Data Analysis

Guided by the objectives and hypotheses set fourth in chapter one of this Thesis, a number of analytical methods are used in this study. They include descriptive, quantitative and qualitative assessments.

Descriptive analysis refers to the use of means, percentages, range and related statistics to describe the general characteristics and trends of the samples surveyed. This analysis set the stage for quantitative and analytical studies. Three quantitative models are used to analyze the effects of selected variables which have been assumed to have an effect on the adoption, consumption and total yield of the SUA 90 bean variety. The selected models are briefly discussed in sections 3.6.1 and 3.6.2 below. The main data analysis for this study was done using the SPSS computer package.

3.6.1 The SUA 90 Bean Variety Adoption Model

The adoption study (which is part of impact assessment) of the Tanzania Bean CRSP Project, like in many other adoption studies (see Hussain *et al.*, 1994; Polson and Spencer, 1992; Grisley and Shamambo, 1993; Adesina and Zinnah, 1993; Akinola. 1987; Adesina and Baidu-Forson, 1995; Green and Ng'ong'ola, 1993; Shakya and

Flinn, 1985; Pindyck and Rubinfeld. 1981), required a model which reflects the empirically observed status of the technology use on the specified area. Such observations reflect a dichotomous variable, *growing* or *not-growing* the SUA 90 bean variety. As pointed out by Shakya and Flinn (1985), this 'adoption behavioural model' with dichotomous (or binary) dependent variables can be used as a conceptual framework to examine variables associated with the adoption of technology.

Although ordinary least squares estimates can be computed for binary models, the error terms are likely to be heteroscedastic leading to inefficient parameter estimates; thus classical hypothesis tests, eg using tests such as t-ratios, are inappropriate (Pindyck and Rubinfeld, 1981). Therefore alternatively, a probability model was employed in this study. The use of probit and logit models, which give maximum likelihood estimators, overcome most of the problems associated with linear probability models and provide parameter estimators which are asymptotically consistent and efficient so that the analogue of the regression t-test can be applied (Pindyick and Rubinfeld, 1981; Amemiya. 1981).

Eliason (1993), Gujarati (1981) and Amemiya (1981), provide an extensive review of probit and logit (or logistic) models. The models have widely been used in adoption studies (refer citation in section 3.6.1, para.1 above). The logit (logistic) model was found suitable for the analysis of the adoption process of the SUA 90 bean variety basing on the above experiences. However, the decision to use the model was also influenced by the fact that the logit model is based on the cumulative logistic probability function and hence computationally easier to use than the other types

(Pindyck and Rubinfeld, 1981). As explained in Gujarati (1988), the choice to use either the logit or probit model for analysis is one of (mathematical) convenience otherwise they would all give out more or less similar results. Conceptually, the following is the logit adoption estimation model for the i^{th} farmer; (Maddala, 1983; Amemiya, 1981; Gujarati, 1988).

$\ln(P^i/(1-P_i)) = b_o + b_iX_i + U_t$

where P is the probability of adoption, b_o is a constant term, b_i is a coefficient to be estimated. X_i is an equation regressor which is assumed to be associated with the dependent variable P and U_t is the disturbance term or error term.

Conceptual Framework of the Study Adoption Model

The conceptual framework of the logistic model used in this study borrows from the following experiences and ideas; (i) the innovation-diffusion model (Rogers, 1962) which accounts accessibility to information about an innovation as a factor influencing adoption decision, (ii) the economic constraint model (Aikens *et al.*, 1975) which relates economic constrains and adoption behaviour in relation to resource endowments, and supported by Haves and Flinn (1976) and Yappa and Mayfield (1978) who pointed out that access to capital and land respectively, could significantly constrain adoption decision, (iii) the so called 'adopter perception' paradigm (Kilvin and Fliegel, 1966a,b,; 1967; cited in Adesina and Zinnah, 1993) which suggests that the perceived attributes of innovations condition adopter's behaviours, (iv) the idea of including demographic factors and those related to farmer's characteristics (Polson and Spencer, 1992; Grisley and Shamambo, 1993; Akinola, 1987) and (v) the recent idea by Adesina and Zinnah (1993) and Adesina and Baidu-Forson (1995) of including the farmer's perceptions of technology-specific characteristics, with the agronomic qualities of a technology being inclusive.

Following Rahm and Huffman (1984; cited in Adesina and Zinnah, 1993), farmers' adoption decisions on SUA 90 bean variety is assumed to be based upon utility maximization. Defining the varietal technologies by j, where j=1 for SUA 90 variety and j=2 for local varieties. The non-observable underlying utility function which ranks the preference of the ith farmer is given by $U(M_{ji}, A_{ji})$. Thus, the utility derivable from the varietal technology depends on *M* which is a vector of farm and farmer-specific attributes of the adopter and *A* which is a vector of the attributes associated with the technology. Although the utility function is unobserved, the relation between the utility derivable from jth technology is postulated to be a function of the vector of observed farm, farmer specific characteristics (e.g., farm size, age, experience of farmer), and the technology specific characteristics (eg., yield, taste, colour, seed size, etc) and a disturbance term having a zero mean.

The utility function can be specified as follows;

$U_{ji} = a_j F_i (M_i, A_i) + e_{ji}$ $\quad j=1,2; i=1,....,n \quad$ (1)

Equation (1) does not restrict the function F to be linear. As the utilities U_{ji} are random, the ith farmer will select the alternative j=1 if $U_{1i} > U_{2i}$ or if the non-observable (latent) random variable $I = U_{1i} - U_{2i} > 0$. The probability that I_i equals one (i.e., that the farmer adopts SUA 90 variety) is a function of the independent variables as shown below:

Let $\quad Y_i = g(I_i) \quad$ where i= 1,2,....,m

by including the set of independent variables the equation for I becomes;

$$I_i - b_o + \sum_{j-i}^{n} b_j X_{ji}$$

where;

$Y_i =$ is the observed response for ith observation (i.e. the binary variable.

$Y_i = 1$ for an adopter, $Y_i = 0$ for a non-adopter) and

$I =$ is an underlying and unobserved stimulus index for the ith observation (conceptually, there is a critical threshold (I_i^*) for each farmer; If I_i is greater than I_i^* the farmer will be highly expected to be an adopter).

g is the functional relationship between the field observation (Y_i) and the stimulus index (I_i) which determines the probability of SUA 90 variety adoption.

$i =$ refers to observations on variables for the adoption model,

$m =$ being the sample size.

$X_{ij} =$ is the explanatory variable for the ith observation, $j = 1, 2,..., n$,

$bk =$ is an unknown parameter, $i = 0,1,...n$ and $k = 0,1....n$, where

$n =$ is the total number of explanatory variables.

The logit model assumes that the underlying stimulus index (I_i) is a random variable which predicts the probability of adoption:

$P_i = Pr(I_i{=}1) = Pr(U_{1i} > U_{2i})$

where P is the probability for adopting SUA 90 variety.

Therefore conceptually, the adoption behavioural model used for the ith observation (an individual farmer) to examine factors influencing the adoption of SUA 90 bean variety was as follows:

$I_i = \ln P^i/1\text{-}P_i = b_o + b_jX_{ij}$ (2)

which is a logit model (Engleman, 1981). This is the basic model in the adoption analysis study.

From the basic model it can be seen that the dependent variable is a natural log of the probability to adopt [(i.e to grow SUA 90 variety) (P)] divided by the probability not to adopt [(i.e not to grow the variety; 1-P)] during and after the introduction of the technology in the sample area (i.e seed distribution exercise in 1990). The relative effect of each explanatory variable (X_{ij}) on the probability of adopting SUA 90 bean variety was measured by differentiating with respect to X_{ij}.

Generally, the empirical logit model of SUA 90 bean variety adoption for this study had the probability of adopting, either by cultivating or consuming the variety, as the dependent variable. Independent variables included; factors related to farmer's characteristics (i.e total farm size, area devoted to beans, farmer's age, experience in bean farming, reasons for growing beans, extension visit, family size,); and the specific qualities of the variety (i.e farmer's perception on palatability, cooking time, keeping quality of dry and cooked seed. seed colour, seed size, yield performance, resistance to disease and pest. the ability to withstand weather fluctuations). The model specification is (2) can be expanded as indicated below;

$$\ln(P^i/(1-P_i)) = b_o + b_1X_{1i} + b_2X_{2i} + b_3X_{3i} + b_4X_{4i} + ...+ b_{11}X_{11i} + U_i$$

where; b_1, b_2,...b_{11} are parameters to be estimated. X_1, X_2,....X_{11} are independent variables assumed to influence adoption. U_i is the disturbance term/error term which represents unobservable socio economic factors and characteristics of surveyed households (i.e. took care of unexplained variation). The error term is assumed to be independently distributed over the survey period. b_o is the intercept. Detailed definition of the selected variables for the adoption model including the underlying assumptions appear in section 3.6.3. The adoption logistic model was estimated using an iterative maximum likelihood algorithm (White, 1978) in order to obtain asymptotically efficient parameter estimates.

3.6.2 The SUA 90 Bean Production (Yield) and Consumption Models

Regression analysis is one of the common methods in social science studies in estimating effects of selected factors on a specified dependent variable. It involves the use Ordinary Least Square Estimation (OLS) to estimate the coefficients.

In this study, two normal multiple regression equations were used to estimate the effect of different selected variables on production (yield) and consumption of SUA 90 bean variety.

The Production model

The model was built from a production function concept where an output Y is produced by using a vector of inputs X_i.

$Y = f(X_1,..., X_n)$.

Therefore any change in Xi affects the output Y.

The empirical model estimated was as follows:

$Yi = a + bXi + u$

where; a is the intercept,

b is a parameter to be estimated,

X_i is a vector of independent variables with i=1,2,...n, and

u is the error term.

It was assumed that the dependent variable i.e SUA 90 yield (in kg/ha.) is influenced by factors like; age of the farmer in years, total bean plot size in ha., area planted with SUA 90 in ha., number of seasons the farmer grows beans per year, area planted with local varieties in ha., household size, average income in Tshs., if the farmer observed the variety withstanding bad weather (eg too little or too much rain), extension contacts, and farmer's experience in bean farming in years, and a dummy for tractor use.

The consumption model

The model used to address consumption factors is based on the static theory of consumer behaviour.

The general model is as follows;

$C_i = a + bX_i + u \quad (i=1,2,.....n)$

where;

C_i is the dependent variable (i.e in this case it is consumption measured by the ratio of amount of SUA 90 seed consumed in kg. over the total amount of beans consumed by a household including local varieties),

a is the intercept,

b is the parameter to be estimated,

X_i is an independent variable which is the factor assumed to have an effect on the dependent variable and

u is the disturbance term.

The study assumed that the consumption pattern of SUA 90 bean variety was influenced by the following variables; yield of local varieties (in this study two most favourite local varieties were identified from the farmer's list in the study area and were used for comparisons) in kg/ha., total bean plot size in ha., yield of SUA bean varieties in kg/ha., average income from selling crops in Tshs., household size, amount of SUA 90 seeds sold in kg., total amount of local varieties consumed in kg., and dummy variables to capture farmers perception on SUA 90 variety's yield performance, palatability, seed size, seed colour, broth quality, cooking time and keeping quality of dry and cooked seed.

The adoption logit model was estimated using an iterative maximum likelihood algorithm (White, 1978) in order to obtain asymptotically efficient parameter estimates. Discussion of the variables included in the multiple regression equations and their underlined assumptions are presented in section 3.6.3 of this chapter.

3.6.3 Selection and Definition of Model Variables

The selection of the variables to be included in the adoption (Table 3.1) and consumption models was guided by the assumption that, SUA 90 bean variety is superior to local varieties currently grown by farmers, and that its adoption and consumption will be governed by the superior qualities embodied in the variety. Other factors like those related to farmer's characteristics (eg. land, age, family size and income) and institutional efficiency (eg. extension and credit provision) will equally affect the SUA 90 variety just like the local varieties. Such factors were included in the models to capture the impact of the variety as to who benefitted from the variety, what influences its adoption and consumption etc. The variables included in the SUA 90 production (yield) model were selected based on the intention of identifying factors that could affect the yield performance of SUA 90 bean variety.

Dependent Variables

(ADOPTION), this is the dependent variable for the adoption model. Farmers who were found still cultivating SUA 90 bean variety in 1996 were considered to be adopters and others non-adopters. It was expected that, farmers would have continued to plant the variety through seasons after being satisfied by its qualities. Termination of cultivation would mean dissatisfaction. This assumes that all other factors were equal and enabled the decision to cultivate the local varieties and not SUA 90 variety. Several independent variables were expected to affect this variable.

(CONSLEV), this is the dependent variable for the consumption model. It was measured by the ratio of amount of SUA 90 seeds consumed in kg. over total amount of beans (including local varieties) consumed in kg. Following the idea that beans are a major source of protein to the majority of people in Tanzania, it was assumed that this ratio increases over time as people continue to like the variety. The amount of beans to be consumed in relation to the total household consumption is increased or reduced by the farmer in such a way that the most preferred variety is taken more. However, availability and cheapness may influence the distribution.

Table 3.1 Definition of variables in the SUA 90 bean variety adoption model

Variable	Definition	Type	Specification
Dependent			
ADOPTION	Adoption of SUA 90 bean variety	Binary	1 if the farmer planted SUA 90 in 1996 and 0 otherwise.
Independent			
YIELDPEF	Farmer's perception on yield performance	Binary	1 if the farmer found the variety superior to the local varieties in terms of yield, and 0 otherwise.
PALATABO	Farmer's perception on palatability and taste	Binary	1 if the farmer found SUA 90 palatable, and 0 otherwise.
BROTH	Farmer's perception on broth quality	Binary	1 if the farmer was satisfied with the quality of SUA 90 broth, and 0 otherwise.
COLOUR	Farmer's perception on seed colour	Binary	0 if the farmer was NOT satisfied with SUA 90 seed colour (poor seed colour), and 1 otherwise.
SEEDSIZE	Farmer's perception on seed size	Binary	0 if the farmer was NOT satisfied with the size (poor seed size), and 1 otherwise.
COOKFAST	Farmer's perception on cooking time	Binary	1 if the farmer found SUA 90 fast cooking, and 0 otherwise.
KIPQUAL	Farmer's perception on the keeping quality	Binary	0 if the farmer found SUA 90 seed of low keeping quality (poor keeping quality), and 1 otherwise.
INCOME	Average income from selling crops	Continuous	A proxy to available money capital
AGE	Farmer's age in years	Continuous	
BPHA	Total area devoted to bean production in ha.	Continuous	
EXTENV	Extension visit	Binary	1 if the farmer had a contact with the extension officer since 1994 crop season.

(YIELD), a variable for SUA 90 yield in kg/ha. is the dependent variable for the SUA 90 yield model. Despite its breeder qualities, the maximum possible yield level of 20 kg of output from 1 kg of seed may not be realised by farmers due to several factors. This variable measures the yield performance of the variety.

Independent Variables

Independent variables were, farmer's perception on the yield performance (YIELDPEF), Palatability (PALATABO), quality of broth (BROTH), seed colour (COLOUR), seed size (SEEDSIZE), cooking time (COOKFAST), keeping quality of both cooked and dry seed (KIPQUAL). The perception on these qualities came out from farmers when they were asked to list the negative and positive qualities (if any) of the variety. There were no direct questions for each quality because it was assumed that by asking a direct question, farmers will be forced to use a specific evaluation criterion provided, while in their normal ways some of the qualities are not of any issue. For example, a farmer may be asked to evaluate the variety in terms of colour while he/she normally does not look at the colour but at the size. Therefore, the idea was to capture the real perception and tastes from farmers guided by their own ways. Farmers have their own ways/criteria for selecting best bean varieties.

The directions of effect of these variables to the dependent variables were hypothesized basing on how farmers perceived them. It was hypothesized that the variables were directly associated with the adoption of SUA 90 bean variety. Yield performance of any variety is very important to farmers because one of the major objectives of farmers is to get a maximum possible level of output at a minimum possible cost. Taste and palatability are important attributes desired by bean farmers (Due *et al.*, 1985). While some people may prefer small seeded varieties for cooking with bananas and at the same time preferring large seeds with rice, others may prefer the opposite. Therefore, tastes for seed size and colour differ among persons as well as from one menu to another. Seed size and colour are therefore, important in consumption and consequently marketing. According to Rugambisa (1990), seed size and seed colour play a significant role in deriving market incentives. The ever increasing shortage and cost of fuel especially the widely used fire wood and charcoal have made farmers prefer fast cooking varieties. Women walk long distances to fetch firewood and therefore the less fuel consuming bean varieties are likely to be preferred.

Since most of the effective storage means eg. use of chemicals and refrigerators are not affordable to majority of farmers, the keeping quality including storability of dry seeds and the shelf life of cooked beans are of great concern to farmers. Farmers want to keep their harvests to the next seasons and keep a portion of the evening meals for breakfast the next day. This habit is very common in Tanzania and therefore it is very important to have varieties that can keep fresh under no refrigeration situation at least for a night after being cooked. In a similar study done in Lushoto district in Tanzania, Due *et al.*, (1985) found that many farmers have storage problems for all varieties although local varieties were relatively better off. However, farmers expect even better keeping qualities from new varieties. Broth quality which is judged from its consistence is also important to farmers because there is a direct link between the strength of broth and taste of food served with it. Beans in Tanzania are mostly served with maize stiff porridge (ugali) and rice which are preferred with strong broths i.e of higher consistencies. The ability to withstand weather fluctuations is important to yield because the rain pattern in the country is currently very unreliable. Palatability, seed size, seed colour, broth quality, cooking time and keeping quality were also expected to influence the consumption pattern of the variety. A negative effect was expected from seed size, keeping quality and seed colour and a positive effect from the rest of the variables. Farmers will tend to consume more of the variety if they are satisfied with the qualities. The variable for the farmer's perception on the SUA 90 bean variety's ability to withstand weather flactuations was expected to have a direct relationship with the dependent variable because a more weather adaptable variety performs better in terms of yield in case of bad weather.

Other independent variables were nominal income (INCOME) in Tshs., age (AGE) in years, total farm size owned (TAHA), total bean plot size (area devoted to beans) (BPHA) in ha., and family size (HHS) which were expected to be directly related to Adoption, consumption and yield of SUA 90 bean variety. For the yield model, household size was used as a proxy for available family labour because this is the type of labour mostly used in bean production in Tanzania. Family size was measured as the total number of persons currently living in each household. Adults, aged children not living at home were excluded. As argued by Akinola (1987), in African context, family plays dual and opposing roles in determining what occurs on the farm and at the same time it provides the human factor in farming through labour and management inputs. The approximate age of the farmer was based on the information elicited from respondents. The expected sign on age is an empirical question: it may be that older farmers have more experience in cultivation and are better able to assess the characteristics of modern technology than younger farmers. However, it could also be that older farmers are more risk averse than younger farmers and have a lesser likelihood of adopting net technologies. At the same time younger farmers are more educated so can have better access to information and will make informed decisions. According to Rogers (1983), young farmers tend to be more flexible in their decisions, adopt new farm practices more readily and due to expected life-span do contemplate a longer pay-off period for investment. It is expected that young farmers could be more willing to adopt SUA 90 variety than their older counterparts. Therefore, according to Polson and Spencer (1991), there is no agreement in the adoption literature on this as the direction of the effect is generally location or technology specific.

Based on the innovation-diffusion literature, it was hypothesized that extension visit (EXTENV) was expected to affect adoption and yield positively because farmers are exposed to 'new information'. A dummy variable for tractor use (TRACTOR) was included in the yield model because tractor use affects per unit productivity and consequently affects yield. However, the direction of effect on yield depends on various factors including farmer's scale i.e whether small or large, because tractor use increases the per unit cost and this depends on the farm size. Therefore the expected sign was an empirical question to this study. The size of the area planted with local varieties i.e local varieties (LOCOHA) in ha. reduce the area to be planted with SUA 90 variety and therefore a negative effect was expected on SUA 90 yield especially because apart from reducing the land share, allocation of time, inputs eg. labour, pesticide etc. and crop management are set into competition. The assumption was also developed after farmers' were observed deciding on the amount of land to be cultivated with a certain bean variety according to the preferences. This means that more land is allocated to the most preferred variety. The area planted with SUA 90 (SUAHA) in ha. and the number of seasons the farmer grew beans (SEASONS) per year was expected to be directly related to yield, because plant population is directly related to area and that more seasons means more plants and consequently more harvests, assuming all other factors being constant.

Yield levels of local varieties (LOCOYLD) was hypothesized to have a negative effect on the consumption of SUA 90 bean variety (CONSLEV) in kg/ha. because more of the local varieties will be available for food especially because beans are mainly produced for home consumption. On the other hand, the yield of SUA 90 (SUAYLD) in kg/ha. was expected to have a positive relationship with consumption by increasing its availability for use. The variable for consumption level of the local varieties (CONSLOC) was assumed to have a negative sign in relation to the consumption level of SUA 90 variety. This is so because the two are competitive goods as they both contribute to the household food budget. The amount of SUA 90 seeds sold (SUASOLD) in kg was hypothesized to inversely affect the consumption level of SUA 90 bean variety by reducing the amount available for farmer's household use. Most of these parameters were obtained from farmers through interviews. The selected parameters and their expected signs are summarized in Table 3.2 below.

Table 3.2 Summary of selected variables and their expected signs

Variable	Expected Signs Model 1	Model 2	Model 3
PALATABO perception of palatability	+	+	
COLOUR perception of seed colour	+	-	
SEEDSIZE perception of seed size	+	-	
YIELDPEF perception of yield performance	+		
BROTH perception of broth quality	+	+	
COOKFAST perception of cooking time	+	+	
KIPQUAL perception of keeping quality	+	-	
AGE age of the respondent	-		?
INCOME average real income	+		+
TAHA total farm size owned	+		+
EXTENV extension contacts	+		+
SUAYLD yield of SUA 90 variety		+	
LOCOYLD yield of local varieties		-	
SUAHA area planted with SUA 90		+	+
HHS household size	+	+	+
SUASOLD amount of SUA 90 seed sold		-	
LOCONS amount of local varieties consumed		-	
SEASONS number of seasons the farmer grew beans			+
LOCOHA area planted with local varieties			-
PBHA total bean plot size			+
WEATHER if observed/not observed SUA90 withstanding bad weather			+
TRACTOR if the farmer used tractor			?
BPEXP experience in bean farming			+

Note:

Model1 - Adoption model
Model2 - Consumption model
Model3 - Yield model
? - empirical question

3.6.4 Limitations of the Data

Although the target sample of farmers for this study was initially set at 300 only 277 farmers participated effectively in the interviewes. The rest of the farmers either showed an obvious interview fatigue (eg in areas where many projects/research activities have been implemented) or did not appear for the interview for reasons not known by the researcher. There were also some technical problems of reaching the farmers at the agreed times eg some of the sample areas could not be reached on time due to impassable roads especially during the long rains eg in Kinole village.

Weather was not favourable in 1995 crop season. Some areas got too much while others got too little rain. This affected the crop badly. Some farmers lost the whole crop and had very little information to give. Although some of them made efforts to get seed from other farmers for consumption comparisons, a good number of them could not contribute much to the consumption section.

During the second phase of data collection, two of the village extension workers who were working with the researcher from the beginning of the study left for further education. Another one was terminated under the civil service retrenchment exercise. This affected the data collection exercise considerably.

Some farmers had problems of memory recall and some could not estimate some of the research parameters like farmsize, age, output harvested, amount sold, amount consumed etc. In some cases the researcher had to rely on their rough estimates.

In spite of the above limitations. the researcher is confident that the data which has been collected is reliable and has adequately addressed the objectives and hypotheses set forth for the study as elaborated in the next chapter of the thesis.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

Study findings and discussion are presented in this chapter. General characteristics of study households in the sample in relation to bean production are presented and discussed for the purpose of separating SUA 90 bean variety adopters from non-adopters. Results from both qualitative and quantitative analyses are presented and discussed. Due to limitation of data and time frame, analysis on the effect of the technologies on environment and labour distribution could not be presented.

4.2 Characteristics of the Bean Producer Households

Before discussing the impact of the introduced technologies at a farm level, it is important to understand the type and characteristics of bean farmers that one is dealing with. The relevant characteristics of the households which grow beans including non SUA 90 bean variety growers are discussed in the subsections below.

4.2.1 Household composition

On average. the household size for the seven villages was found to be six persons with 50% females. However, for Ulaya, Magole and Mgeta, the number of females exceeded that of male members by one (Table 4.1). The minimum and maximum numbers of members in a household across the sample villages were 1 and 19 respectively. The maximum value was observed in Kinole village.

The majority of the members in the sampled household were below twenty years of age (Table 4.1) while very few members belonged to other age groups. This implies that those families had more dependents than producers. Each family, at least on average, had a member with age above 60 years, but this was not necessarily the household head. This adds on the dependent group. The fact that there were few members in the most productive age group i.e. 20 - 40, one can safely assume that most families experience farm labour shortages.

4.2.2 Household Head Characteristics (Respondent Farmer)

Marital status

Most of the interviewed farmers were married and therefore the household heads were men. About 82 percent of the respondents were married, while single, widowed and divorced were 8.8, 4.4 and 3.3 percent respectively. Among the singles, 70.7 percent were women implying more involvement of unmarried women in bean farming than unmarried men.

Table 4.1: Bean producer household composition by sample villages, 1996.

Village	Household size					Household Members Age Groups				
	Average	Minimum	Maximum	Male	Females	Below 20	20-30	30-40	40-60	above 60
Kisanga	4	1	10	2	2	2	1	1	1	1
Msolwa	6	1	14	3	3	3	1	1	1	1
Ulaya	7	3	13	3	4	4	2	1	1	1
Dumila	6	1	12	3	3	3	2	1	1	1
Magole	7	2	12	3	4	4	2	1	1	1
Kinole	8	1	19	4	4	4	2	1	1	1
Mgeta	9	3	14	4	5	5	2	2	1	1

Source: Survey Data, 1996.

Alternatively, bean farming was preferred mostly by unmarried mothers (70.7%) who might have children than unmarried men who formed only 29.3% of the single farmers group. Marital status has a bearing on accessibility to resources like land, labour, capital and decision making process. Single women, especially those having children[2] will normally have little land (probably given by parents) than the married ones who have better access (not ownership) to land by being able to cultivate on their husbands' land. According to the prevailing customary laws, land is mostly owned by men. Consequently married women tend to be better off than their counter parts who are mothers but not married as far as accessibility to land is concerned. In Kisanga and Msolwa it was found that married women cultivated both their husbands' plots and their personal plots (the latter mostly offered by parents). It was also observed that divorced women lose the right to cultivate the former husband's land but retained it in case of widowhood. By having children to feed all by themselves, single mothers including the divorced and widows have relatively little chances of accumulating cash for purchase of resources like land, farm implements etc. This was indicated by the bigger number (74%) of unmarried mothers reporting to have obtained land from their parents while only 4% indicated they bought their land.

Marital status among women was observed to have a strong relationship with general land distribution and acquisition in the sample villages area (also refer section 4.4.1).

[2] Note, in most cases children born without marriage normally remain with their mothers.

Women in Dumila and Magole for example related their poor crop productivity to the type of land given to them by the village administration. In discussing with women respondents it was observed that in some cases and especially to the divorced, widowed and single mothers, men tend to allocate the less productive plots to women. Sometimes women are given land that has been used by some men for quite a time and whose productivity has declined.

Age

The average age of the respondents was found to vary across the seven villages ranging between 34 and 50 years. The mean ages per village were 34. 39, 49, 40, 45, 40, 44 years in Kisanga, Msolwa, Ulaya, Dumila, Magole, Kinole and Mgeta respectively. The youngest bean farmers among the seven villages were 18. 19, 25. 20, 20, 18 and 23 in Kisanga, Msolwa, Ulaya, Dumila, Magole, Kinole and Mgeta respectively.

The average age of the sample indicate that the majority of farmers are young. This has a bearing on the availability of resources as well as contacts with extension. Dynamism, better education and risk taking are normally expected among youths than for elders. This could increase the possibility for research and extension programme impacts. Due to their mobility, physical energy, dynamism and flexibility, young farmers are likely to adopt new innovations. However, older farmers have a wealth of farming experience, patience and in the traditional societies these would have more access to resources and especially land.

Education

Education level is an influential factor in technology adoption as it could have a bearing on taste, choice and awareness. The majority of the respondents for this study (about 58%) attended primary schools. Twenty two percent attended adult education classes. About 6.4 percent of the sample farmers had not attended formal education with more women than men falling in that group (Table 4.2). About 3.5 percent of the total sample reported to have attained secondary education or above. This means that majority of farmers have been to school and they know how to read and write and therefore information can be extended using written documents like posters, booklets, leaflets, bulletins etc.

Results show that all the farmers in Mgeta attained primary education or above (Table 4.2). This data might be misleading and possibly is a reflection of problems that might have occurred during sampling. It is suspected that the final selection of farmers to be included in the sample which was unavoidably assigned to the Mgeta (Langali) village extension worker had a kind of bias favouring the known potential farmers. However, this is not expected to have any serious implications on the inferences made in other findings because primary education is almost guaranteed to all citizens.

Table 4.2: Formal education level by sex for sample villages in Kilosa and Morogoro Rural Districts, 1996

Village		Formal Education Level															
	N	None				Adult Education				Primary Education				Secondary Education & above			
		M	F	T	%	M	F	T	%	M	F	T	%	M	F	T	%
Kisanga	48	-	4	4	17.4	1	-	1	2	28	3	40	20	3	-	3	37
Msolwa	70	2	3	5	21.7	5	10	15	33	23	26	49	25	1	-	1	13
Ulaya	21	-	2	2	8.7	2	4	6	13	9	3	12	6	1	-	-	13
Dumila	24	1	1	2	8.7	1	2	3	7	7	12	19	9	-	-	-	-
Magole	19	1	1	2	8.7	2	-	2	4	8	7	15	7	-	-	-	-
Kinole	75	5	3	8	34.8	9	10	19	41	32	6	48	24	-	-	3	-
Mgeta	20	-	-	-	-	-	-	-	-	13	4	17	9	2	1	8	37
TOTAL	277	9	14	23	100	20	26	46	100	120	71	200	100	7	1		100

Source: Survey Data, 1996

4.3 Adoption of Tanzania Bean CRSP Project Technologies

Following the distributions of SUA 90 seed in 1990 and 1994, a survey was carried out in 1996 to evaluate the early adoption process. The technology distributed was the variety alone without an agronomic recommendations package. The technology was expected to fit in the existing farming systems and therefore no agronomic practices were specified for the variety. Therefore, the study sample farmers were expected to adopt the variety and grow/ manage it along with other varieties and in their usual ways.

About 59.9 percent of the sampled farmers, out of which 42.7 percent were women, were still cultivating the variety. These are referred to as adopters in this study. Results also show that EP4-4 and NITROSUA are not yet popular technologies among the majority of interviewed farmers. Only 5.6 and 2.3 (1.9% men and 0.4% women) percent knew the EP4-4 variety and NITROSUA respectively. Therefore the discussion in this study is mainly on SUA 90 bean variety.

Findings show that the variety has been accepted by almost half of the sample farmers. The non-adopters group, according to the study includes even those who might have liked the variety but due to certain constraints could not cultivate the variety as well as other varieties. For example, one woman farmer in Kisanga reported that, " I did not cultivate SUA 90 variety this year because I had to travel to Dar es Salaam and take care of my daughter who was seriously sick and by the time I came back the season was already gone". Another farmer in Magole desperately reported that, " I was very angry when I found that my daughter had cooked the beans that I reserved for seed. I went to my friends but nobody was in a position to offer me some. So please when you come next time try to bring me some, even half a tin". Other claims include poor storability of previous harvests which led to lack of seed, illness, lack of money for hiring land and death of a husband during the season (note that some culture require a widow to stay "in-door" for about forty days after the burial). Therefore, the adoption rate of SUA 90 variety is probably an underestimate of the actual adoption process which has taken place. However, there is an expression of willingness to continue growing the variety especially farmers who could not cultivate the variety because of lack of seed. Although it was possible to learn about their willingness to adopt by asking about their next season's plans, this was affected by the fact that some of them were not available for the interview. This contention is also supported by the fact that SUA 90 seeds are also being distributed through farmer to farmer transfers where by SUA 90 growers sell the seeds or give them freely to their fellow farmers (refer to the discussion in section 5.4).

Although results show that majority of SUA 90 adopters are men i.e 57.3 percent (ie. 42.7% of the 59.9% are women), observations show that women are the majority among the bean farmers in the sample area. Therefore, it is possible to argue that women would have adopted more if it was not for some socio-economic factors which bound them as discussed above. However, among other reasons, it is also possible that men adopted more because of their social power and accessibility to resources.

The study findings show that the adoption rate in Kilosa district was higher than in Morogoro Rural district. About 64.2 and 52.4 percents of farmers From Kilosa and Morogoro Rural respectively adopted the variety. This means that considering the adopters group, 68 percent came from Kilosa district. This can probably be a reflection of the performance of the variety in these two areas in relation to agronomic requirements of the variety. Overall, about 60% of the sample farmers introduced to SUA 90 variety in the two districts have adopted the new seed.

The adoption rates by location in the two districts are indicated in Table 4.3.

Table 4.3: The distribution of SUA 90 bean variety adopters and non-adopters in sample villages by sex, 1996.

	KILOSA DISTRICT												MOROGORO RURAL DISTRICT									TOTAL N = 172		
	Kisanga N=30			Msolwa N=50			Ulaya N=11			Dumila N=10			Magole N=9			Kinole N=50			Mgeta N=12					
	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	Total
Adopters																								
Frequency	11	8	19	15	16	31	3	4	7	4	4	8	4	2	6	13	8	21	9	2	11	59	44	103
%	58	42	63	48	52	62	43	57	64	50	50	80	68	33	67	62	38	42	82	18	92	57	43	60
Non Adopters																								
Frequency	6	5	11	12	7	19	3	1	4	1	1	2	1	2	3	10	19	29	-	1	1	33	36	69
%	55	46	37	63	37	38	75	25	36	50	50	20	33	67	33	35	66	58	0	100	8			
TOTAL																								
N	17	13	30	27	23	50	6	5	11	5	5	10	5	4	9	23	27	50	9	3	12	92	80	172
%			17			29			6			6			5			29			7			100

Source: Survey Data, 1996

M= Male, F = Female, T = Total

4.4 Characteristics of SUA 90 Bean Variety Adopter vs Non-adopter Farmers

According to Bernstein *et al*.(1992) social impact analysis moves beyond measuring the extent of adoption of new technologies and rate of return to consider the characteristics of adopters vs non adopters with respect to factors such as labour availability, farm size, gender, access to credit, extension and marketing services, for the purpose of determining who has benefitted from the research; i.e large or small-scale farmer, women or men, rich or poor or middle class consumers. Basing on the above rationale the sub sections which follow investigate the characteristics which distinguish SUA 90 adopters and non adopters.

4.4.1 Accessibility to Resources

Literature shows that farmers who have resources are more likely to adopt new innovations than those who are not (Aikens *et al*., 1975; Havens and Flinn, 1976; Yappa and Manfield, 1978). However, it is also true that simple innovations are adopted more by the resource poor farmers than the rich ones. Therefore, whether or not the resource poor will adopt, depends on the type and requirements of a specific innovation. A comparison between SUA 90 bean variety adopters and non-adopter farmers in relation to accessibility to different resources is presented below.

Land

Land is the most important resource to a farmer, and its availability is of great concern. Land is generally not privately owned in Tanzania. The colonial land lease system is still used in Tanzania where a land tittle for 33, 99 or 999 years is granted. The lease system is mostly used in the urban and peri-urban areas and hardly by the rural dwellers except for the rural investors who need land. However, this law is now under extensive review and following the introduction of open market system, the new law is directed towards private ownership of land. Most of the farmers in the rural areas do not have land tittles. The commonest mode of acquiring land in Tanzania is through inheritance. However, new settlements are established and people clear land and create temporary ownership of land.

Results show that for the pooled sample of adopters and non adopters, 41.1 percent inherited land while 19.1 percent cleared new land, 17.3 percent were offered land by friends, parents and other relatives. About 13 percent bought and 9.4 percent hired. It seems that hiring of land is not very common in the sample area (Table 4.4). Although the findings show that both men and women participated in almost all modes of land acquisition, the commonest modes for women varied across the villages (Table 4.4). Information in Table 4.4 reveals that more women inherited land in Kinole and Mgeta villages than in other villages, may be because Kinole and Mgeta have a relatively matrilineal culture. Eighty eight percent of the interviewed women in Kinole and 50 percent in Mgeta inherited land as compared to 20 and 30 percent in Dumila and Kisanga respectively. In Dumila the commonest mode for women to acquire land was to buy. However this may not be typical of other parts of the district because Dumila is a newly formed village with a mixture of people from different places and it could as well be classified as a small town (along the Dar es Salaam - Dodoma road) and hence patterns of land transfer/acquisition may not be typical of other villages - especially those in the remote parts of the district[2]. Kisanga and Msolwa villages also have a mixture of people who have migrated mainly from Iringa and Tanga regions. These migrants cleared land and settled.

Mgeta and Kinole are traditional villages and almost every piece of land is owned by a certain family. Ownership of land is then transferred through generations. Observations show that the interviewed women who claimed to have inherited land mainly referred to their husbands', i.e their husbands inherited the land which is used as a family land. This implies that women did not inherit land *per-se* but the husbands (i.e husbands inherited the family land). This is reflected by the big number of married women inheriting land. For example, 76 percent of the women who inherited land were married, 14% widowed, 8% divorced and 2% single. When the married women were asked to explain about the ownership of their personal land, the tendency was to talk about the family land which is basically owned by the husband and was sometimes referred to as "our land". Therefore, when a married woman was reporting that she inherited the land, literally the meaning was that "the land that she cultivates was inherited" and not necessarily by her. Therefore, ownership of land to women is still a problem.

Discussions with women farmers show that they downplay the importance of owning land themselves (probably because such land would customarily be transformed to the elder sons). To them the most important thing is to get a plot where they can cultivate and derive their livelihood no matter who owns the land. This is an important point for noting because by having such a duality, the whole process of facilitating and promoting gender balances in land ownership is affected. Such women will own land in one generation but transfer it back to men in the second generation through their elder sons.

Table 4.4: Mode of Acquiring Land by Sex for farmers in the study villages, 1996.

Village	N	Mode of Acquiring Land																			
		Inherited				Bought				Hired				Offered				Cleared land			
		M	F	Total	%	M	F	Total	%	M	F	Total	%	M	F	Total	%	M	F	Total	%
Kisanga	48	10	8	18	37.5	3	1	4	8.3	3	-	3	6.3	4	5	9	18.8	12	2	14	29.2
Msolwa	70	7	8	15	21.4	7	5	12	17.1	3	7	10	14.3	4	8	12	17.1	10	11	21	30.0
Ulaya	21	3	4	7	33.3	1	1	2	9.5	1	1	2	9.5	3	3	6	28.6	4	-	4	19.0
Dumila	24	2	1	3	12.5	4	7	11	45.8	-	4	34	16.7	1	1	2	8.3	2	2	4	16.7
Magole	19	4	3	7	36.8	1	-	1	5.3	2	2	4	21.1	1	-	1	5.3	3	3	6	31.6
Kinole	75	28	23	51	68.0	2	2	4	5.3	1	1	2	2.7	11	3	14	18.7	4	-	4	5.3
Mgeta	20	9	4	13	65.0	2	-	2	10.1	1	-	1	5.0	3	1	4	20.0	-	-	-	-

Source: Survey Data, 1996

The average farm size observed was 3.2 ha. of which 0.5 ha (i.e about 15.6%) was devoted to bean production. Maize seemed to occupy the largest part of the area, as it occupied about 46.8 percent (1.5 ha) of the total area owned. Farmers were found to have different plots for different crops and as explained in Due *et al.*, (1985) that farmers have specific areas for growing beans. The average number of plots was found to vary from one village to another depending on the type of crops grown and the location of land suitable to those crops. For example, the land suitable for rice cultivation is very specific and farmers have to seek plots in the wet areas. The average and maximum values of number of plots owned were 3 and 9 respectively. The majority had between 3 to 5 plots (Table 4.5). Some of the plots were observed to be very far from homesteads and farmers had to spend much time walking to them. In all the seven villages. most of the bean plots were found to be in the lower plains. In Ulaya village, more than three quarters of the plots were along the river banks. In Kisanga, Msolwa, Kinole and Mgeta the bean plots were up in the hills but on the plateaus. When farmers were asked to explain how they selected the areas for cultivating beans, the common answer was that they were selecting lower areas which keep moisture (or late to dry - as they put it) for some time even after the rains. Some bean plots especially in Kinole, Ulaya and Mgeta were within bigger plots cultivated with perennial crops like bananas, coconuts etc. Some bean plots were observed to resemble home gardens. During the survey, some farmers were observed alternating beans with other crops on the same land while others used it solely for beans. In Mgeta, farmers grow beans in monoculture in the second season after maize had been harvested.

Table 4.5: Distribution of number of plots of SUA 90 growers and non-growers.

	SUA 90 growers		SUA 90 non-growers	
Number of plots owned	Number of farmers	percentage	number of farmers	percentage
0 - 2	37	35.2	36	35.0
3 - 5	58	55.2	 59	57.2
6 - 8	8	7.6	8	7.8
9 - 11	1	1.0	-	0.0
above 11	1	1.0	-	0.0
TOTAL	105	100	103	100

Source: Survey Data, 1996.

The average farm size owned by adopter farmers was 3.1 ha which is close to the overall mean. Out of this about 0.6 ha (19.35%) is devoted to bean production. This is compared to an average land of 2.85 ha owned by the non adopters of which 0.5 ha (18.6%) is devoted to bean production. The difference in farm size between the two groups was about 0.25 ha. Both had almost the same amount of land. The difference between the two means was not statistically significant (P=0.6). The proportion of the land devoted to beans was different with adopters allocating about 0.1 ha more for bean production than the non-adopters. This difference should not be over looked as far as bean production is concerned because the crop has a relatively higher number of plants per area because of lower plant spacing. It seems that those who adopted the variety do in general have larger areas for bean production than the non adopters. The distribution of total land owned and the land devoted to bean production for adopters and non-adopters is summarized in Tables 4.6 and 4.7 below. The classes were categorized by computer using minimum, maximum and range tatistics for variable land in hectares.

Table 4.7 show that for both adopters and non adopters the land allocated for beans increased from 1992 to 1995 especially for farmers with bigger plots i.e from 1.25 to more than 2 ha. For example, in 1992, only 2 adopters allocated more than 1.25 ha while in 1995 their number increased to 10. As for non adopters the number increased from 4 farmers to 7. On the other hand the number of bean farmers who allocated land with sizes ranging between 0 and 1.25 ha decreased from 101 and 65 in 1992 to 88 and 58 in 1995 for adopters and non adopters respectively, implying an increase in the land allocated for beans from 1992. When the means of the two groups were tested the difference was found to be statistically significant (P=0.003).

Table 4.6: Total land owned (in ha.) by sample farmers.

Land size category (ha)	Adopters		Non-Adopters	
	Frequency	%	Frequency	%
0 - 1	19	18.4	18	26.1
1.1 - 2	31	30.1	12	17.4
2.1 - 3	21	20.4	15	21.7
3.1 - 4	15	14.6	3	4.3
4.1 - 5	2	1.9	2	2.9
5.1 - 6	7	6.8	5	7.3
above 6	8	7.8	4	20.3
TOTAL	103	100.0	69	100.0

Source: Survey Data, 1996.

Table 4.7: Total land devoted to beans production (in ha.) by sample farmers, 1996.

Farm size (in ha)	Adopters				Non adopters			
	1992		1995		1992		1995	
	Freq	%	Freq	%	Freq	%	Freq	%
0.00 -0.25	48	47	40	28.8	24	35	20	28.9
0.25 -0.50	26	25	22	21.4	19	28	10	14.5
0.50 -0.75	20	19	25	24.4	13	19	15	21.7
0.75 -1.00	6	6	5	4.9	6	9	9	13.0
1.00 -1.25	1	1	1	0.9	3	4	4	5.8
1.25 -1.50	-	0	1	0.9	1	1	1	1.4
1.50 -1.75	2	2	5	4.9	2	3	3	4.3
1.75 -2.00	-	0	2	1.9	1	1	2	2.9
above 2.00	-	0	2	1.9	-	0	1	1.4
TOTAL	103	100	103	100	69	100	69	100

Source: Survey Data, 1996.

Labour

The majority of farmers in the country rely on family labour with only a smaller proportion depending on hired labour. However in some cases farmers use both family and hired labour. About 65 percent of the interviewed farmers used both family and hired labour in their farms. Labour is hired mostly for land preparation and weeding. Out of 277 cases 86 used family labour alone, these form 31 percent of the total sample. Only 4 percent hired labour for all the farm activities. The rest used both family and hired labour. This is so because most of these families had few members in the most productive age group (Table 4.1).

The majority of both adopters and non-adopters used both family and hired labour. Very few, about 2.9% of adopters and 3.1% of non-adopters used hired labour alone. Labour is hired mostly for maize and rice production especially during weeding, harvesting and threshing. Overall, the majority of farmers use family labour in bean production.

For bean production, peak family labour demands are during weeding and threshing and it is when labour hiring is done. In most cases no slack family labour is experienced during the above activities. It was also observed that harvesting and threshing of beans are mainly done by women and children. This includes winnowing and drying. In Dumila and Magole, four of the men farmers interviewed, mentioned that they do not normally participate in sowing and weeding of beans because these were women's activities. The situation in Kinole was observed to be similar to the above. In Kisanga and Msolwa villages both men and women were observed participating in all processes including the winnowing of beans.

Capital

Most of the sample household interviewed had farming as the major source of income (and capital for further investment) through sale of crops. Income obtained from farming varies from one farmer to another depending on the type of crops grown and the producer prices obtained. It has been observed in the sample areas and even in other parts of Tanzania, that farmers who produce cash crops like tobacco, cotton, sugarcane and coffee together with those who produce food crops mainly for market, have relatively more earnings than others. It is important to note that, the number and types of farm outputs contributing to the household's annual income are vast. These include even crops which are not meant for cash eg. papaws, cucumbers, coconuts from a single plant around the homestead etc. This was observed during the field visits where such crops were displayed on mats or baskets for sale infront of farmers' houses. For example, in Kinole the commonest of these were sweet (ripe) bananas, papaws, pieces of sugarcane, black berries and few coconuts.

Results show that about 56.3% of both women and men had annual income of between 10 000/= and 100 000/= Tshs., with 51.7% of these lying between 50 000 and 100 000/= Tshs. About 6.1 percent of all the respondents (more than half of them being women) had income below 10 000 Tshs. This implied that women were the majority among the low income earners. Very few (i.e 8%) respondents had income above 200 000 Tshs. (Table 4.8). The difference between adopters and non adopters was not statistically significant (P=0.7).

Basing on the fact that in Tanzania beans are mainly produced for food, less capital inputs are normally invested in its production. Nevertheless, in some areas like Kisanga, Msolwa and Mgeta, substantial amounts of beans are produced for the market through some capital investment in bean production.

Table 4.8: Distribution of average income from selling crops of sample farmers in Tshs -1995.

Income level (Tshs.)	Adopters	Non adopters
below 10	4	5
10 - 50	28	16
50 - 100	30	12
100 - 150	15	9
150 - 200	11	9
above 200	15	18
TOTAL	103	69

Source: Survey Data, 1996

4.4.2 Accessibility to Other Farm Inputs

Fertilizers and pesticides

Results as summarized in Table 4.9 show that majority of both adopter and non adopter farmers used neither chemical fertilizers nor chemicals for controlling diseases and pests. Only about 8.6 percent of the whole sample claimed to use fertilizers. This is probably because the soils of the sample villages and mostly those of Kisanga and Msolwa were still fertile. About 21 percent reported the use of pesticides. Pesticide were used mainly for controlling storage pests and not in the fields. Chemical fertilizers and pesticides were not readily available or affordable by the majority of small farmers interviewed. For those who used fertilizers and pesticides, 51.6 percent got them from extension officers, 22.6 percent bought from private sellers and 19.4 percent from cooperative unions. Very few got them from friends (3.2%) and other sources (3.2%). The distribution of fertilizers and pesticides used by the sample farmers for each village is summarized in Table 4.9 and the difference between the two groups is not significant.

Farm machinery and implements

Regarding farm implements, 97.5 used hand hoe and only 17.3 and 0.7 percent used tractors and ox - ploughs respectively. Ox-ploughs were used only in Dumila village as livestock keeping is still uncommon in the sample area.

Tractor use is not common in bean production in Tanzania. It is mostly common in land preparation for maize, rice and cotton. There are some few farmers who use tractors for threshing maize and sometimes for transport. This implies that bean production is yet to be undertaken by farmers with large farms who use modern implements.

Only 18.4 and 17.4 percent of the adopter and non-adopter farmers respectively, reported to have used tractors in their farms (Table 4.9). This means that majority of the farmers in the sample area do not use tractors in farming. It was observed that the tractor hire charge per acre (0.4 ha) during the 1995/96 crop season was 10 000 Tshs. The tractors were owned by individual farmers and some belonged to communities like churches, cooperative unions, research centres and villages.

Irrigation

Irrigation was practised in some of the villages visited eg in Kisanga and Msolwa (from river Iyovi), in Ulaya (from river Muyombo), Kinole (from river Mbezi), and in Mgeta (using river Mgeta). Most of these rivers flow throughout the year except river Iyovi whose water level decreases during the dry season. Not all the farms were near to these rivers, and therefore not all farmers could practise irrigation. About 59 farmers in Kisanga and Msolwa practised irrigation and increased the number oftheir farming seasons. Results show that both adopters and non adopters experienced similar circumstances as far as irrigation practice is concerned i.e there was no statistical difference between adopters and non adopters (P=0.4). Only 23.84 percent of the whole sample practised irrigation and adopted SUA 90 bean variety while only

15.7 percent practised irrigation but did not adopt the variety and this was equal to 39 percent of all the non adopters (Table 4.9).

4.4.3 Credit

Credit is among the important sources of capital which is however not yet available to the majority of the small holder farmers. The credit system in Tanzania is not very favourable to small holder farmers and many farmers do not have access to credit facilities. Following the introduction and implementation of the market economy in Tanzania, credit accessibility and availability to small holder farmers has deteriorated considerably. The financial institutions like The National Bank of Commerce (NBC) and The Cooperative and Rural Development Bank (CRDB) which are the major credit institutions in the country have formulated new policies and business strategies which are geared towards commerce, marketing and industry, and less to agriculture and even lesser to small holder farmers. The policies include the removal of credit subsidies and increased interest rates (Kashuliza *et al.*, 1996a). These together with the high collateral requirements like land tittles make it very difficult for the small holder farmers to obtain credit.

A number of non governmental organisations (NGOs) are currently very active in financial support to small holder farmers in some areas of the country. But these are very few and intermittent. They work on small areas and therefore not sustainable because very few people can get credit in this way.

Results show that 91.3 percent of the respondent had never had access to credit facility. constraints mentioned and reasons mentioned include; (1) poor availability (48%) (2) lack of interest (11.4%) (3) afraid of risk (12.6%) and (4) never thought of credit (12.2%). Sixty percent of the of the farmers who reported to have had access to credit they had obtained it from informal sources like friends, relatives etc. Only one percent of the total sample got credit from banks. The cooperative unions had offered credit to about 15 percent of the farmers interviewed.

One of the two women who reported to have obtained credit mentioned specifically that credit was obtained from her elder brother on condition that she returns the money with two bags of paddy. Generally there is no diference between adopters and non-adoptes as far as access to credit is concerned. This implies that adoption of SUA 90 bean variety did not favour farmers with access to credit and *vice versa.*

4.4.4 Extension Service

It has been documented that extension visits and contacts have a positive effect on the adoption process by exposing farmers to new information (Adesina and Baidu-Forson, 1995; Polson and Spencer, 1991). The above study shows that extension service can influence adoption both directly and indirectly (through farmer to farmer contacts i.e farmers can communicate with neighbours and friends and the extension message is passed through to the whole society).

Each village in the sample had at least one village extension officer. Sixty eight percent of farmers (both SUA 90 growers and non growers) had contacts with extension officer at least once during the 1993 season. In order to exclude the effect of the extension contacts made during the study period in 1994 - 1996, the year 1993 was used to study the frequency of extension contacts. Results show that fifty one percent of those who had contacts, the frequency was between 2 - 3 times per season. Only 12.2 percent contacted the extension worker more than 5 times. The common way of contacting the worker was either the farmer called the extension worker when in need (37.8%) or the extension officer visited farmers at own time (38.3%). About 13.7 percent said that the extension officers were available at any time. Generally farmers contacted village extension worker mainly for advice on crop management (60.4%) and on disease problems (26.7%). Only 5.9 percent got advice on storage issues.

Findings show that about 58.1% of the sample farmers had contacted the extension officer at least once. The majority of the interviewed farmers indicated that they started to communicate with extension officers only recently. Out of these 52.6 percent had contacted the extension worker about 2 to 3 times per season while 21.1 percent contacted the worker more than 5 times. Although the percent of farmers who had contacts with the extension worker was only marginally above 50 percent, almost all the farmers including the 41.9 percent who had no contacts, claimed to get all the important and new information delivered by the extension worker, through their friends. When the farmers who had no contacts with extension workers were asked if they felt that they miss valuable information by not contacting the extension worker, on the average the answer to this question was negative because some farmers felt that the same information could be obtained from their fellow farmers who are known to have frequent contacts with the extension workers. However, after the first seed distribution which was done in the presence of the village extension workers, the number of visits by extension workers to these farmers increased for both adopters and non-adopters.

Table 4.9: Distribution of fertilizer, pesticide, irrigation use and accessibility to credit in sample villages, 1996.

	Kilosa District									Morogoro Rural														
	N=30 Kisanga			N=50 Msolwa			N=11 Ulaya			N=10 Dumila			N=9 Magole			N=50 Kinole			N=12 Mgeta			N=172 Total		
	Y	N	%	Y	N	%	Y	N	%	Y	N	%	Y	N	%	Y	N	%	Y	N	%	Y	N	%
Fertilizer use																								
Adopters	-	10	0	-	31	0	-	7	0	1	7	10	-	6	0	5	16	10	8	3	67	14	89	8.2
Non-adopters	-	11	0	-	19	0	-	4	0	-	2	0	-	3	0	1	28	0		1	0	1	68	0.6
Pesticide use																								
Adopters	3	16	10	-	31	0	-	7	0	1	5	10	3	3	33	2	19	4	1	10	8.3	10	93	5.8
Non-adopters	-	11	0	10	9	20	-	4	0	-	2	10	1	2	11	15	13	30	-	1	0.0	27	42	15.7
Irrigation																								
Adopters	6	13	20	18	13	36	1	6	9.1	1	7	10	1	5	11	3	18	6	11	-	97	41	62	23.8
Non-adopters	3	8	10	10	9	20	-	4	0.0	1	1	10	2	1	22	10	19	20	1	-	8	27	42	25.7
Access to credit																								
Adopters	1	18	3	2	29	4	1	6	9	1	7	10	-	6	0	1	20	2	1	10	83	7	96	0.6
Non-adopters	11	11	0	2	17	4	3	1	27	-	2	0	2	1	22	2	27	4	-	1	0	9	60	5.2
Total	24	98		42	158		5	39		5	33		9	27		29	160		22	26		136	452	86.0

Source: Survey Data, 1996.

Note: Y = Yes, N = No

% = Y for adopters/village N

The general characteristics of adopters vs non adopters are summarized in Table 5.1 below.

Table 5.1: Household and farm characteristics of adopters and non adopters of the SUA 90 bean variety, in sample villages.

Parameter	non adopters	adopters
Household size	6.67	6.54
Yield from SUA 90 (kg/ha)	578.57	821.0
Total farm size (ha)	2.85	3.15
Total bean plot size (ha)	0.59	0.62
Total bean yield (kg/ha)	1 079.50	1 355.90 *
Yield of local varieties (kg/ha)	476.30	411.70
Total bean consumption (kg)	69.76	74.80
Amount of SUA 90 consumed (kg)	3.12	4.96 *
SUA 90 bean plot size (ha)	0.07	0.80
Total bean sold (kg)	253.32	202.41
Local varieties plot size (ha)	0.52	0.54
Maize plot size (ha)	1.2	1.4
Rice plot size (ha)	0.55	0.66

Note: * significant at 5% level of confidence.
Source: Survey Data, 1996.

4.4.5 Production Priorities

Most of the farmers interviewed did not produce beans as a principle crop. Maize is the main crop in all the farming systems visited. Only 44 out of 277 cases were found producing beans as the main crop and this was equal to only 15.9 percent. Out of this, 13.9 percent did not adopt SUA 90 bean variety and about 2.9 percent adopted. This means that out of the whole group of adopter farmers, only 4.8 percent produced beans as the main crop. These results are consistent with findings by Due *et al*. (1985) that beans are produced mainly for food and are produced in association with other crops like maize and bananas.

It can be seen from the results that SUA 90 bean variety has not been adopted by farmers who produce beans as a principal crop. This could be due to the fact that the variety is still relatively new in the farming systems and does not yet have well established market outlets. Therefore, some farmers still give priority to their well known varieties. When responding to the question as to why a farmer did not cultivate SUA 90 variety in 1996, one farmer in Msolwa village mentioned that he could not identify buyers for the previous harvests (in Dar es Salaam where he normally sells most of his beans) and therefore he decided not to cultivate it until the market is well established. The response given by his customers was that they did not know the variety. This implies that by finding its market, SUA 90 bean variety may become a priority crop in the farming systems of many farmers.

4.5 SUA 90 Bean Variety Production and Adoption Potential

It was found from the study that SUA 90 variety was new to the sample villages. Following this study about 78.7 percent of the respondents have now heard about SUA Bean Project and 85.2 percent (out of which 27.1 percent did not get seed from the project) now know SUA 90 bean variety.

Observations show that in sample area, SUA 90 bean variety has been accepted by farmers because many farmers (78.6%) of them were asking for more seed during the study's interviews. Other bean varieties found to be common across the sample villages included various types of Canadian Wonder which were known by almost 91 percent of the interviewees and a variety locally known as 'soya'/'Kablanketi' known by 85.2 percent. Other varieties found in the villages with their respective percentages of farmers who know them in parentheses were; 'Masai Red' (64.6), 'Kabanima' (8.7), Lyamungu 85 (13 percent). 'Kombati' (14.2 percent), 'Rungemba' (24.8). 'Arusha nyekundu' (12.2) and 'Arusha nyeusi or simply 'maharage meusi' (17.3 percent). These results imply that adoption of technologies is not an instant event because some improved varieties like Lyamungu 85 have taken quite a time to be known. Therefore more time is required to get the real impact and adoption of the introduced varieties.

From the little seed distributed, it has been observed that SUA 90 variety was relatively preferred to some local varieties like 'Rungemba', 'Kombati' and 'Maharage meusi'. However the variety competed with 'Soya' and 'Canadian wonder' (maharage mekundu) which seemed to be preferred by at least every bean farmer interviewed. Canadian wonder is preferred for the high prices it fetches in the market although it is not high yielding and soya is preferred for its high yielding characteristics though it has relatively lower market prices.

From the sample, the average yield for SUA 90 across the seven villages was 821 kg per ha and that of local variety yield was 491 kg per ha. However, the average levels varied among the villages. The levels of SUA 90 yield differ between adopters and non adopters (Table 5.2). The average SUA 90 yield levels were 821 and 578.57 kg per ha for adopters and non adopters respectively. Fifty five percent of the adopter farmers obtained SUA 90 yield levels above 900 kg/ha as compared to about 30% of the non adopters. Sixty five percent of the non adopters obtained SUA 90 yield levels below 500 kg/ha.

Table 5.2 Distribution of SUA 90 bean variety yield (kg/ha) by adoption.

Yield (kg/ha)	No of adopters	No of non-adopters
0 - 100	3	4
100 - 200	1	15
200 - 300	1	3
300 - 400	5	7
400 - 500	5	12
500 - 600	6	5
600 - 700	5	2
700 - 800	8	1
800 - 900	12	1
900 - 1000	25	1
Above 1000	32	18
TOTAL	103	63

Source: Survey Data. 1996.

The hectarage for SUA 90 bean variety was low as compared to other varieties. 92.5% of the respondents planted SUA 90 seeds in 0.1 ha (0.25 acre) especially because the amount of seeds supplied to them was low ie. 1 kg. The average size of the area cultivated with bean crop in 1995 was 0.58 ha. The general trend shows that the area devoted to beans had increased from 1992 to 1995 (Table 4.7). The number of farmers with bean farms ranging between zero and 0.25 ha decreased from 1992 to

1995 (i.e from 46.6% to 28.8% for adopters and from 34.8% to 28.9% for non adopters) while that of those with above 2 ha increased from 0 percent to 1.9 for adopters and from 0 percent to 1.4% for non adopters. Generally adopters had allocated more land for bean production in 1995 than was the case in 1992, eg, in 1992 only 2.8% of the adopters had more than 1 ha of land devoted to bean production but in 1995 the number had increased by 7.7%.The number of non-adopters who increased their bean farm area by more than 1 ha during the same period also increased (by 6.8%).

It was also observed by the study that the area for SUA 90 bean variety had increased during the 1996 crop season when farmers had different seed volumes saved from the previous harvests. During the 1994/95 crop season farmers were supplied with 1 kg of SUA 90 and this is what was planted by most farmers. But during the 1995/96 crop season different amounts of seed were cultivated depending on how much was harvested in 1994/95 season as well as how much was saved for seed by a household.

Results show that the majority of the farmers who have recently joined the bean production enterprise are men (Table 5.3). From the whole sample 6 men (3.8% of the men) and 4 (3.3% of the women) women had an experience of less than a year in bean farming. All farmers in Ulaya Dumila and Mgeta villages tend to have more than one year of farming experience and this implies that beans have been cultivated by most farmers in the recent past. About 79.5 percent of women had a bean farming experience of more than five years whilst only 52 percent of men had that level of experience. The majority of the men farmers (43.6%) in the sample area had an experience of between 1 and 5 years while the majority of the women farmers (43.8%) had an experience of between 5 and 10 years. About 35.5% of women and 30% of men farmers interviewed had 10 or more years of experience in growing beans. Among women, 15.7% have had years of bean growing experience ranging between 1 and 5. Therefore, women are more experienced in bean farming. However, in areas where beans are among the important cash crops like Kisanga, Msolwa and Mgeta, men have relatively more experience in bean farming than the men in other villages. For example, from the whole sample, 59.4%, 61.3% and 80% of men in Kisanga, Msolwa and Mgeta respectively, had more than 5 years of bean farming experience as compared to 41.7%, 33.3%, 45.4% and 41.3% of men in Ulaya, Dumila, Magole, and Kinole respectively..

Table 5.3 Farmer's experience in bean production by sex in the sample villages - (Number of years)..

Experience in years	Kisanga		Msolwa		Ulaya		Dumila		Magole		Kinole		Mgeta		Total	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Less than 1	2	2	1	1	-	-	-	-	1	-	2	1	-	-	6	4
1 - 5	11	2	11	7	7	2	6	2	5	1	25	4	3	1	68	19
5 - 10	11	3	8	18	3	1	1	10	2	2	9	18	1	1	35	53
More than 10	8	9	11	12	2	6	2	3	3	5	10	5	11	3	47	43
TOTAL	32	16	31	38	12	9	9	15	11	9	46	28	15	5	156	119

Source: Survey Data, 1996.

Most farmers were found producing beans both for family consumption and market. Therefore the tendency was to produce different varieties. Women tend to produce beans for their families first and sell them when they need quick cash to solve problems like sickness. deaths. school fees and materials. food items like salt etc. Only seven women farmers were producing beans for sale only as compared to 47.4% of the men farmers. About 79.4% of women produced beans for both sale and family consumption, whereas only 45.6% of men farmers produced beans for both sale and family food. This implies that beans play an important role in the food basket of rural households especially where the crop is controlled by the women farmers. Men farmers tend to produce beans for sale. This was reflected by the high number of men growing beans for sale only. Although income from such sales could still be used to meet food demands of the households - such end results can not be guaranteed because of the fungibility of money.

Table 5.4: Distribution of farmers' responses on reasons for growing beans by sex in the sample villages (number).

Reason	Kisanga		Msolwa		Ulaya		Dumila		Magole		Kinole		Mgeta		Total	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
For family consumption	10	6	4	1	1	2	2	7	6	4	5	4	2	-	22	7
For sale	2	1	5	1	10	7	-	-	1	-	-	2	-	-	7	76
Both	20	9	23	37	10	-	7	8	4	4	39	26	13	5	92	73
Total	·32	16	31	39	21	9	9	15	11	8	44	32	15	5	121	156

Source: Survey Data, 1996.

Results show that farmers are positive with qualities of SUA 90 bean variety. About 74.7 percent of all the farmers who received SUA 90 seed said that they were ready to continue planting the variety while 64.2 percent of the non growers said that they were ready to start growing the variety. The majority of SUA 90 growers (76.4%) mentioned that SUA 90 variety is good and out of these forty percent have actually adopted the variety. About 27.5 percent of the non adopters said that they were ready to continue cultivating the variety and this includes farmers who could not cultivate the variety in 1996 due to social problems like illness, deaths or lack of seed. This implies that, out of all those who claimed that they were ready to continue to cultivate the variety, 49.5 percent replanted it during the 1995/96 crop season, i.e the actual adopters. About 41.6 percent of the non adopters (14.8% of the whole sample) said that the variety is bad and that are not ready to continue planting it. The rest were positive with the variety although not all replanted it in 1996 crop season. These are the SUA 90 adoption potentials.

Results also show that farmer to farmer transfer of SUA 90 seed has already started. About 22 farmers bought their own SUA 90 seed while 32 got it free from SUA 90 growers. This implies that farmers are getting SUA 90 seed from their fellow farmers. Basing on these results it is expected that more farmers will distribute SUA 90 seed to other farmers and make SUA 90 popular. This indicates a diffusion potential for the variety.

4.6 Consumption

Generally it has been found that beans are important food for many families in the sample households. The average beans (both local and SUA 90 varieties) consumption levels per household in all the seven villages were high. The average consumption level of SUA 90 variety per household was 4.72 kg with a minimum of 0.5 kg and a maximum of 12 kg per year in 1995/96. Since the seed provided was only a kilo, and the expected yield was 20 kg at most; and since farmers had to save part of the yield for seed, this consumption level is therefore high. As for local varieties, the two most favoured varieties across the villages i.e. Canadian wonder and the so called 'soya' were selected and used for comparisons in this study. The average consumption levels are 49.76 kg and 21.22 kg per year for Canadian wonder and 'soya' respectively. Other varieties like 'rungemba', 'kombati', small black seeded variety locally known as 'Arusha nyeusi' were also consumed but by few of farmers and in small amounts. The most preferred variety was Canadian wonder followed by 'soya'.

In analyzing the consumption of SUA 90 variety, 70% were found to consume more than 4.72 kg which was the average. It was also found that about 87% consumed more than half of what was harvested. About 50% and 88.9% were found to consume amounts well above the averages of Canadian wonder (49.76 kg per year) and 'soya' (21.22 kg per year) bean varieties. This implies that during the 1995/95 harvests majority of the respondents consumed about 1 kg per week. It should be noted that especially with coconut juice or dairy milk. Two women in Kisanga village were fond of its positive response to traditional cooking i.e the variety tastes good when prepared in the traditional ways.. However, majority preferred beans from green pods than dry.

As mentioned earlier in chapter three, farmers were asked to mention the positive and negative qualities of the variety and therefore whatever was not mentioned by a particular farmer implied that the farmer does not find it of any issue or does not use the quality as a criterion for judging the quality of a variety. The obtained results show that 96.5 % of the interviewees did not find seed colour and size of any issue to them and so do the seed size, broth and keeping quality (Table 5.5). Therefore, it is possible to argue that majority of farmers are indifferent to characteristics relating to seed colour and seed size (in comparison to those who find these important). Most of the respondents found tastes and palatability important.

To summarise the results, it is shown that the most important criteria considered in selecting SUA 90 bean variety are palatability (67.4%) and cooking time (64.1%). Only 3.5% and 6.4% were negative with the seed colour and size respectively. This is a very useful information to breeders.

Table 5.5: Distribution of farmers' responses on the consumption qualities of SUA 90 bean variety

Quality	General Concern with the Quality										Comments with Specific type of food (most preferred)			Not concerned (Not an issue)			
	Positive			Negative			Overall Total				Ugali	Rice	Ban	M	F	T	%
	M	F	T	M	F	T	M	F	T	%							
Palatability	63	50	113	-	3	3	63	53	116	67.4	80	20	1	29	27	56	32.6
Broth	7	10	17	1	-	1	8	10	18	10.5	-	-	-	84	70	154	89.5
Colour	4	1	5	1	-	3	5	1	6	3.5	-	-	-	87	79	166	96.5
Seed size	-	5	5	3	3	7	3	8	11	6.4	9	-	-	89	72	161	93.6
Cooking Time	53	52	105	2	5	7	55	57	112	65.1	75	19	2	37	23	60	34.9
Keeping - Quality	4	2	6	7	10	17	11	9	20	11.6	-	-	-	81	71	152	88.4
TOTAL	131	120	251	14	21	38	145	138	283		164	39	3	407	342	749	

Source: Own Survey,1996.

Note: Ugali = refers to stiff porridge which is a staple food in most parts of Tanzania.

Ban = refers to banana

4.7 Impact on Income and Marketing Issues

It is still too early to establish impacts on household income levels because the market channels for SUA 90 variety have not been well established. However, from the average levels of amount sold, it can be concluded that SUA 90 is beginning to penetrate the local market. From the whole sample the average amount of SUA 90 seed sold per household was 11.44 kg while the average consumption level was 6.89 kg. This shows that more seeds were sold than consumed. As for local varieties, the average amount sold was 1142.7 kg. The respective average amount consumed was 99.9 kg, also lesser than the respective amount sold.

When the means for total bean yield and total amount sold (i.e for both local and SUA 90 varieties) were compared between SUA 90 growers and non growers, the difference between the two was found to be statistically significant at P=0.01 and P=0.04 respectively. The differences were in favour of the SUA 90 growers (see Table 5.1). This implies that there was some impact on the SUA 90 growers' earnings because by cultivating SUA 90 variety extra harvests were obtained and a household had extra amounts of beans for sale (of either SUA 90 itself or the local varieties).

Constrained marketability of SUA 90 seeds was observed in all the seven villages visited especially because the variety is still new and the amount of seeds grown is still too small. However, it is expected that with time the variety will be known by more people and fetch its market, consequently, production will be stimulated. The output from SUA 90 bean variety was thus limited and hence not enough for family food, for the next season's seed and for sale. Except for fifteen cases, most of the farmers did not sell SUA 90 seeds. The marketing problem was mentioned by 50% of the men farmers and 9% of the women farmers. Undoubtedly, the marketing problem must have forced some farmers to rate the variety negatively. This study suggests that in future one of the project's priorities should be the market promotion of the varieties (and technologies) which have been released by the project eg SUA 90. One of the potential market areas where such promotion can be made are primary schools, eg one male farmer in Msolwa was found selling beans to primary schools in the area for their meals.

4.6 Problems in Bean Farming

Farmers reported that they were faced with several problems in bean cultivation. These include; seed shortages, disease and pest infestation, unfavourable weather, market problems, land availability and lack of input facilities like labour and credit. From the interview results, seed shortages and weather fluctuation are the major problems of bean farming in the visited area. However, there were sharp differences between sexes with regard to problems of bean production. While 82% of women farmers felt that seed unavailability was a problem only 42% of the men felt so. Also 60% of the men farmers mentioned marketing as a problem while only 49% of the women mentioned it as a problem.

The second most frequently noted problem among men and women was unfavourable weather. It should be noted however that problems mentioned above relate to bean farming in general and do not specifically relate to SUA 90. Therefore. there were no specific problems mentioned addressing SUA 90 variety specifically. About 10% of the respondents (these came from Dumila and Magole villages which have relatively low rains as compared to other villages in the sample) mentioned that SUA 90 is drought tolerant and that it performed better that the local varieties in dry areas. One farmer in Dumila explained that he has a feeling that probably SUA 90 bean variety should be cultivated in dry areas because apart from the experience he got during the 1995/96 crop season. the farmer gave some of his SUA 90 harvest to a relative in Dodoma which is a very dry region and the variety performed better than in Dumila.

4.7 Storage

Storage problems of dry seed for both local and SUA 90 bean varieties have been reported by farmers. However. farmers reported that SUA 90 variety appeared to be more susceptible to storage pests than some local varieties. This problem might be associated with the fast cooking characteristics of the variety, because cooking time is associated with the hardness of the seed coat or testa. i.e, the softer is the testa the shorter is the cooking time and the easier it would be for the insect to prick in. It was also mentioned by farmers that some of the traditional storage methods like drying, use of ash and cowdung had failed to protect SUA 90 from some storage pests. The storage of SUA 90 cooked seeds was also mentioned as a problem (Table 5.5 for responses on keeping qualities).

4.8 Empirical Results on Adoption, Production and Consumption Variables

Two types of empirical models were estimated in this study. A logistic regression model was used to estimate the effect of selected variables on the adoption of SUA 90 bean variety. Two multiple regression equations were estimated for various factors associated with SUA 90 yield and Consumption. Results from these models are discussed below.

4.8.1 Estimated Logit Model for SUA 90 Bean Variety Adoption.

The summary statistics for the logit model as presented in Table 5.6, showed that 78 percent of farmers adopting improved SUA 90 bean variety were correctly classified. A maximum of six iterations were required for convergence of the model. The likelihood ratio test indicates that the models, as specified, explained significant non-zero variations in factors affecting farmer's technology adoption behaviour. This led to the rejection of the null hypothesis that there is no relationship between the dependent variable and the set of all explanatory variables. Chi-squared statistics was also computed to test the joint effects of the independent variables. The chi-squared value was found to be highly significant at 1% level of confidence.

Use of maximum likelihood approach yielded parameter estimates that are asymptotically efficient and consistent. Parameter estimates were evaluated at the 0.01. 0.05 and 0.10 significance levels. Six of the eleven parameters included in the alternative specification of the bean technology adoption decision model were significant. The most significant parameter relate to perception of farmers on palatability which was significant at 1%. Others were yield performance, cooking time, age of the farmer, average income from selling crops and total farm size owned which were significant at 5%. The signs of all significant parameters estimates, except income and total farm size, were consistent with previous expectations. Factors such as seed colour, seed size, broth quality, keeping quality and extension contacts were not significant in the adoption of SUA 90 bean variety.

Similar results on seed colour and size were obtained in Uganda by Grisley and Mwesigwa (1990) who found that preferences for beans are a function of taste but grain size and colour were not strong indicators or proxies of taste. These outcomes are also supported by Schwartz and Pastor-Corrales (1989) who established that there is usually a strong market incentive for certain grain colours and types; but the strength of colour and size preferences varies from place to place. Although these factors were insignificant, they showed a direct (positive) relationship with adoption indicating that, the probability of adoption increases with positive perception of colour and size of SUA 90 bean seed. Probably, broth and keeping quality were insignificant because farmers have different ways of preparing and keeping food.

Strength of broth also depend on recipes. Things like coconut or dairy milk, amount of tomatoes added etc. could affect broth and keeping quality of cooked beans.

Extension contact was found to be not influential as far as SUA 90 bean variety adoption decision is concerned. The negative sign was not expected because of the reasons discussed in section 3.6.3. However, the inverse relationship can be explained by past experiences on adoption of technologies, especially if the previous technologies advocated by extension workers were associated with costs like use of expensive inputs or crop failure. Such past experiences might cause farmers not to be among the first adopters but wait until the technology has been proved useful by others. Therefore, if a farmer experiences frequent extension contacts which lead to adoption of poor technologies, there is a possibility of such a farmer not willing to adopt any more technologies.

The insignificance of extension contact can also be possibly explained by institutional and extension service inefficiency in the country as it has not succeeded in educating farmers on the use of improved varieties (Mattee, 1994). A negative relationship between extension contacts and adoption was also obtained by Hussain *et al.* (1994). In their study, the effects of training and visit extension programme was found to be negatively related with adoption of new varieties and use of phosphorous fertilizer. From the same study extension radio programmes were found to have no effect on adoption, despite their apparent positive effect on farmer's knowledge. Overall extension contact had a significant effect on adoption of chemical weed control, but not on use of new varieties or phosphorous fertilizer.

Because farm size is an indication of level of economic resources available to subsistence farmers (Akinola 1987), probabilities of adopting improved varieties increases as this resource base increases (Polson and Spencer, 1992). Contrary to this theory, an inverse relationship was obtained in this study. Results show that, the probability of adopting SUA 90 bean variety increases as the farm size decreases. The reasons for this can follow the explanation by Polson and Spencer, 1992) that farmers producing on larger farm sizes were commercially oriented, and they produced small marketable surpluses to satisfy some level of household financial needs. Therefore, since SUA 90 bean variety has not found its market yet, it is thus not surprising that it has not been adopted by market oriented large farmers. About 32 farmers experienced yield levels above 1000 kg per ha and they couldn't sell all the produce as a result they were forced to consume and give freely to neighbours, relatives and friends. During the 1996/97 crop season 17 of these farmers reduced their production levels while 9 did not grow the variety.

Table 5.6 Estimated logistic model for factors affecting the adoption of SUA 90 bean variety in the study areas.

Variable	Estimated Beta Coefficient	S.E of beta	T - Ratio
Intercept	- 2.6387	1.0185	2.5908 **
Perception of palatability (PALATABO)	1.9554	0.4336	4.5097 ***
Perception of seed colour (COLOUR)	7.0963	14.1845	0.5003
Perception of seed size (SEEDSIZE)	0.1836	0.6925	0.2651
Perception of yield performance (YIELDPEF)	0.7569	0.3664	2.0658 **
Perception of broth quality (BROTH)	0.0009	0.5932	0.0015
Perception of cooking time (COOKFAST)	0.2134	0.1101	1.9382 **
Perception of keeping quality (KIPQUAL)	0.0231	0.0127	1.8189
Age of respondent (AGE)	0.1537	0.0996	1.5432 **
Average income (INCOME)	- 0.9710	0.5301	1.8317 **
Total farm size (TAHA)	- 0.7560	0.4725	1.6000 **
Extension contacts (EXTENV)	- 0.2096	0.3413	0.6141

Goodness of fit	261.288
Chi - Squared value	89.480 ***
Log of likelihood function	363.616 *
Likelihood Ratio Test Value	274.140 *
Farmers correctly classified	77.700 percent
Total number of observation	277.000

*** significant at 0.01 level of confidence.
** significant at 0.05 level of confidence.
* significant at 0.1 level of confidence.

Source: Survey Data. 1996.

From the significant variables, it was found that adoption increases with age. This means that older farmers are more likely to adopt SUA 90 bean variety than younger ones. This supported the idea that bean farming is mostly produced by small - scale farmers. Farmer's perception on palatability , yield performance and short cooking time increased adoption. Farmers who think that SUA 90 bean variety is superior in terms of palatability, yield performance and cooking time are more likely to adopt the variety than those who think otherwise. Empirical results indicated that adoption of the variety is likely to be higher among the low income earners (poor farmers) than is the case for their counterparts (ie. relatively richer farmers).

4.8.2 Multiple Regression Analysis Results

In order to identify and estimate effects of selected variables on production (yield) and consumption of SUA 90 bean variety, two regression equations were fitted with variables explained in chapter three (see section 3.6).

Consumption Model

For the consumption model, it was assumed that farmer's have their own tastes and preferences in relation to specific qualities embodied in bean varieties. Therefore, these together with other socio-economic factors were expected to influence the consumption level of SUA 90 bean variety. Preferences were included in the model as dummies. The ordinary least square method was employed to estimate the model. The results are shown in Table 5.7.

Results show that the partial regression coefficients for household size, seed colour, seed size and keeping quality were not statistically significant in explaining the variation in the consumption of SUA 90 bean variety. The coefficients for amounts of local varieties consumed and the dummies for palatability and cooking time were highly significant at 1% level of confidence. Coefficients which were also statistically significant included, the yield of SUA 90 bean variety, yield of local varieties, area planted with SUA 90, amount of SUA 90 seed sold, amount of local varieties consumed and household size which were significant at 5% level of confidence. The dummy for quality of broth was significant at 10% confidence level. The direction of effect of these variables to the dependent variable was as expected and explained in section 3.3.6 except for household size and yield of local varieties. In total, the variables included in the model explained about 59 percent of the variation in SUA 90 bean variety consumption. Since the F-ratio is highly significant (at P=0.00), it is most likely that the variables in the model affect the dependent variable (Table 5.7).

Table 5.7 Estimated linear regression model for factors affecting the consumption of SUA 90 bean variety in study areas, 1996..

Variables	Regression coefficient	S.E of Beta	T - test
Constant	0.029	0.018	1.619 *
Yield of SUA 90 bean variety (YIELD)	0.003	0.001	2.566 **
Yield local varieties (LOCOYLD)	0.004	0.001	2.439 **
Area planted with SUA 90 variety (SUAHA)	0.091	0.035	2.587 **
Household size (HHS)	0.018	0.014	1.264 **
Amount of SUA 90 seed sold (SUASOLD)	0.020	0.098	- 2.050 **
Amount of local varieties consumed (LOCONS)	0.015	0.002	- 7.528 ***
Dummies for: Palatability (PALATABO)	0.093	0.029	3.201 ***
Seed colour (COLOUR)	- 0.59	0.056	- 1.071
Seed size (SEEDSIZE)	- 0.023	0.071	- 0.323
Quality of broth (BROTH)	0.073	0.043	1.686 *
Keeping quality of cooked and dry seed (KIPQUAL)	- 0.010	0.042	- 0.246
Cooking time (COOKFAST)	0.088	0.022	3.948 ***

R^2 61.8 %
R adjusted 58.6 %
F - statistic 19.59 ***
Note: ***, ** and * significant at 1%, 5% and 10% confidence level.
Source: Survey Data, 1996.

The *a priori* assumption for the household size variable was governed by the notion that big families consume more food. The variable was considered to be very important because it is obvious that food requirements increase with family size. Results also support this argument.

The dummy for farmer's perception on the keeping quality of SUA 90 cooked and dry seeds was inversely related to the dependent variable as expected but not significant (at P=0.10). The variable was expected to have a negative effect on the dependent variable because if farmers feel that the keeping quality is poor then less of the variety will be consumed as discussed in section 3.3.6. It is most likely that the variable is not significant because farmers have different storage knowledge and facilities or else they tend to believe that all varieties have storage problems and they have learned to live with the problem. This is also supported by the survey results presented in Table. 5.5 showing that about 88.4 percent of the respondent farmers were not concerned with the keeping quality of the variety. They did not use it as a selecting criterion.

The positive sign on the yield of local varieties was not expected because local and SUA 90 bean varieties are competitive goods competing for the household food and market share. It can also be explained by the fact that as yield of both SUA 90 and local varieties increase, the consumption levels also increase. On the other hand, yield of local varieties and amount of SUA 90 consumed by a household are inversely related because the household will always consume more of what they have in store rather than buying. Therefore, if more of local varieties is harvested possibly more of it will be consumed as compared to SUA 90 bean varieties (note, the dependent variable is the ratio of amount of SUA 90 beans consumed to the total amount of beans consumed by the household including local varieties). Therefore, by increasing the yield from local varieties the amount of SUA 90 to be consumed is reduced. However, a direct relationship (the positive sign) may be due to the relationship between the yield of local varieties with other variables which affect the dependent variable like the amount of SUA 90 seed sold. By increasing the yield of local varieties more of it is available in the market and it is possible that less amounts of SUA 90 are bought. This will indirectly increase the amount of SUA 90 to be consumed by SUA 90 farmers because they will sell less of that variety and eat more.

SUA 90 Yield Model

The yield model included dummies to capture the effect of specific agronomic qualities of the variety on the yield. The ordinary least square method was employed to estimate the model. Results are presented in Table. 5.8.

Partial regression coefficients for household size which was used as a proxy for family labour, area planted with local varieties, age of the farmer, adaptability of SUA 90 variety to bad weather and average income, were not statistically significant in explaining the variation in SUA 90 yield levels (Table 5.8). The coefficients for number of seasons, tractor use and experience in bean farming were highly significant at 1% level of confidence. Total farm size. extension contacts. total bean plot size and area planted with SUA 90 were significant at 5% confidence level. The direction of effect of the variables to the dependent variable was as expected except for total farm size. extension contacts, tractor use and average income. This is possibly because large farms necessitate the use of tractor which results into extensive cultivation and ultimately cause a reduction in yield levels per ha. In total, the variables included in the model explained 69% of the variation in SUA 90 yield. The F statistics was significant at 1 percent level of confidence.

The negative sign on the variable "total farm size" was not expected because it was assumed that farmers will have more land that can be used for bean production. However. the observed sign may be due to the farmers' tendency of devoting more land to crops with good market. This means that since bean is still regarded as a food supplementing crop to majority of farmers in Tanzania. there is a possibility that farmers will tend to distribute land in such a way that more land is devoted to crops or varieties with market higher incentives. This may involve a shift of household resources like capital, time, labour, fertiliser etc. from bean or specifically from SUA 90 variety production especially during this period when the variety is still new to farmers.

Table 5.8 Estimated linear regression for factors affecting SUA 90 bean variety yield in the study areas.

Variable	Regression coefficient	S.E of beta	T - test
Constant	69.39	40.23	1.73 **
Total farm size owned (TAHA)	- 4.19	2.38	-1.76 **
Number of seasons the farmer grew beans (SEASONS)	32.05	11.63	2.76 ***
Household size (HHS)	1.60	1.78	0.89
Area planted with local varieties (LOCOHA)	0.08	0.08	0.99
Extension contacts (EXTENV)	- 23.62	12.09	-1.95 **
Total bean plot size (PBHA)	32.59	13.36	2.44 **
Age of the farmer (AGE)	5.01	7.26	0.69
Whether or not the observed SUA 90 withstanding bad weather (WEATHER)	12.95	21.08	0.61
if the farmer used tractor (TRACTOR)	- 50.21	14.97	-3.35 ***
Average income (INCOME)	- 2.21	3.88	-0.05
Area planted with SUA 90 bean variety (SUAHA)	49.94	22.14	2.25 **
Experience in bean farming (BPEXP)	62.94	13.09	4.81 ***

R^2 0.69
R adjusted 0.61
F - statistic 12.41 ***
Note; ***, **, * . Significant at 1%, 5% and 10% respectively.
Source: Survey Data, 1996.

The unexpected negative relationship between extension contacts and dependent variable is a challenge to this study because as discussed earlier in section 3.6.3, extension contacts are expected to increase farmer's knowledge and hence improve his production. However, observations show that not all farmers adopt whatever is recommended by extension officers. Some do not adopt because of lack of resources, ignorence and some are just rigid. It is also possible that some extension messages are not properly delivered or delivered not at the right times and places. These may cause lower productivity among farmers. On the other hand, the negative sign may be related to the prevalent inefficiencies in the extension channels in Tanzania.

The effect of the average income on the dependent variable was very insignificant as represented by a very low value of the coefficient hence considered to be not important.

The *a priori* assumptions/expectations on the direction of effect for variables on the dependent variable were not specific for variables "tractor use" and "age" due to reasons explained in section 3.6.3. From this study, age is positively related to SUA 90 yield. This implies that older farmers are more experienced and have acquired a lot of knowledge in relation to bean farming. Unfortunately, the variable was not significant possibly because bean farming is practised by all age groups and farming starts from childhood. As for tractor use, a negative relationship was obtained. Use of tractor is normally associated with larger area under cultivation and hence extensive cultivation. This normally reduces the average yield per ha.

The parameter for "total consumption level" was not significant in influencing causing a variation on the SUA 90 yield, possibly because not all farmers plan their farming activities in relation to their consumption levels. However, in many households the decision on the amount of land to be planted with a certain crop or variety is sometimes influenced by a speculated amount of food requirement.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Study Objectives and Hypotheses

The general objective of this study was to assess the impact of the technologies introduced by the SUA Bean Project to small holder farmers. A major emphasis of the study was on the adoption, diffusion, effect on the small farmers' wellbeing and the consumption pattern of SUA 90 bean variety versus other varieties. Primary data for the study were collected from a random sample of 277 bean farmers in Morogoro and Kilosa districts using standardized questionnaires and through personal observation. Additional information were collected through unstructured interviews of some field extension workers and other key informants. Secondary data were obtained from published documents and the SUA Bean

The study was guided by four hypotheses. These were: (i) SUA 90 bean variety have been adopted by small holder farmers and replaced some local bean varieties; (ii) SUA 90 bean variety exhibits a positive impact on crop yield and incomes of small holder farmers; (iii) SUA 90 bean variety is preferred by consumers in comparison to local varieties due to its superior characteristics; (iv) NITROSUA, EP4-4 and other technologies of the SUA Bean Project have contributed to farmer's wellbeing.

5.2 Study Findings, Summary and Conclusion

Since its establishment in 1982, the Tanzania Bean CRSP Project has developed three technologies which have been tested in different farmers' fields. Those are SUA 90 and EP4-4 bean varieties and NITROSUA. SUA 90 bean variety was released in 1990 and seeds have been distributed to farmers in Morogoro, Arusha, Mwanza and Kilimanjaro region. More seeds were distributed during 1994/95 crop seasons. EP4-4 bean variety is still in the pipeline undergoing its final tastes for release. This study's findings and conclusions are organised by the study objectives as follows hereunder;

(a) Objective one: *To assess the adoption process and diffusion of SUA 90 bean variety and related bean project technology.*

Generally the study findings support the argument that in Tanzania beans are mainly produced by small holder farmers. The average farm size for both SUA 90 growers and non growers was found to be 3.2 ha. of which 0.5 ha. is devoted to bean production. This implies hat on the average, only about 15.6% of the total land owned is used in bean production. Observations show that farmers grow and will continue to grow different varieties of beans for different reasons. It is very unlikely that farmers may grow a single variety however superior it is in terms of tolerance and taste qualities be cause farmers prefer different tastes for diet change as well as different agronomic behaviours for risk management. Therefore, the key issue here is to assess the SUA 90 variety as to what extent has SUA 90 bean variety been accepted and integrated into the farmer's production environment. Acceptability/integration were established through estimation of technology adoption and diffussion rates (these same measures also serve as proxy estimations of the technology impact).

Results from this study show that 59.9% of the respondents who have been introduced to SUA 90 variety have adopted the variety. Out of these, 42.7% are women. EP4-4 variety and NITROSUA are least known, because only about 5.6% and 2.6% respectively, of sample farmers were aware of the two technologies. The majority of adopters were found to be men i.e men adopters made up 57.3 percent of the total adopters in comparison to 42.7 percent of women. This might have been caused by the usual tendency of women adopting new technologies after men mainly due to culture and poor accessibility to resources.

Although beans were grown by all the sample households visited only about 4.8% of the adopters produce beans as the main crop in their farming systems. For the rest of the households beans are produced as a second or third priority crop after such crops as maize and paddy. In principle the main crop ofa household would be relied on in generating the necessary cash and/or food supplies. The second or third crop would still serve these same objectives but at a lower scale level. This implies that, although there are very few farmers who produce beans as a main crop (and all of them have adopted SUA 90 bean variety). this small group conveys a possibility of SUA 90 bean variety being produced as a principle crop along with other varieties. These farmers will play a very important role in establishing SUA 90's market assuming that the variety is sold along with other varieties produced by these farmers. This will make SUA 90 popular in the market and more farmers will adopt it as a cash crop and consequently making it available even to households which do not cultivate beans but rely on market purchase.

Results also show that 85.2 percent (out of which 27.1% did not get seed from the project) know SUA 90 variety. This is promising especially because the variety was quite new in some areas. About 74.7% of all the farmers who received SUA 90 seed said that they were ready to continue planting the variety especially if consumers are made aware of the variety and seeds are made readily available in the local markets. About 27.5% of farmers who tried but not grew the variety during 1996 (i.e the non adopters) said that they were ready to continue cultivating it.

The study's field findings show that farmers have distributed SUA 90 seeds to other farmers. For example, while 22 of the reporting farmers indicated they had sold their SUA 90 seeds, 32 of the farmers indicated they had offered seed freely to their fellow farmers and relatives. This implies that a farmer to farmer transfer of seed has been initiated and farmers are getting SUA 90 seed from their fellow farmers. From these results it is reasonable to expected that more farmers will transfer SUA 90 seed to other farmers. Thus the diffusion potential for the variety appears to be high.

Results from the empirical analysis show that variables related to perception of farmers on palatability, yield performance and cooking time have significantly influenced the adoption of SUA 90 bean variety. Other important variables with influence on adoption of SUA 90 variety include; age of the farmer, average income from selling crops and total farm size owned. Factors such as extension contacts, perception on seed colour, seed size, broth quality and keeping quality did not affect the adoption of the variety. The important factors above are indicative of the areas where the project should put more emphasis for further promotion of the developed varietal technologies.

(b) Objective two: *To establish the impacts of SUA 90 bean variety and related technologies on small holder farmers.*

This objective was guided by the hypothesis that SUA 90 bean variety exhibits a positive impact on crop yield and incomes of small holder farmers. Results show that by growing SUA 90 bean variety, farmers exhibited additional bean yield levels and sales. In the absence of the variety farmers experienced approximately same levels of yield and production costs.

For SUA 90 growers (i.e both adopters and non adopters), the average amount of SUA 90 seed sold was 11.44 kg while the average yield was 699.78 kg per ha. When the means for total bean yield and total amount sold (i.e for both local and SUA 90 varieties) were compared between SUA 90 growers and non growers, the difference between the two was found to be statistically significant at P=0.01 and P=0.04 respectively. This implies that SUA 90 has had impact on the growers' earnings.

Regression results show that the farmer's household size (which represents the available family labour), total farm size, extension contacts, total bean plot size, area planted with SUA 90, area planted with local varieties, age of the farmer, adaptability of SUA 90 variety to bad weather and average income, explained the variation in SUA 90 yield levels. The variables; number of seasons, tractor use and experience in bean farming expressed stronger effects on the SUA 90 yield. This implies that the variation on the SUA 90 yield is mostly explained by factors related to the farmer's personal characteristics and his environment rather than the characteristics of the variety itself. The implication is that the variety is high yielding given favourable production environment. It is observed that most of the factors discussed can be influenced by the farmer except for extension which is institutional and adaptability to weather which was partially statistically significant at 10% level of confidence.

(c) Objective three: *To evaluate the consumption pattern of SUA 90 variety vis-a-vis other varieties.*

Generally it has been found that beans are important food for many families in the sample households. The average levels of units of different varieties consumed per household in all the seven villages are high. The average consumption level of SUA 90 variety is 4.72 kg with a minimum of 0.5 kg and a maximum of 12 kg. Since the farmer had to save part of the harvests for seed and may be for sale, this consumption level is therefore high. The two most favoured local varieties across the villages were Canadian wonder and the so called "soya" (similar to kenya). The average consumption levels were 49.76 kg and 21.22 kg respectively.

Seventy percent of the respondents consumed more than 4.72 kg which was the average. This means that large amounts of the harvested SUA 90 bean crop were consumed. It was also found that 87% consumed more than half of what was harvested. About 50% and 88.9% of farmers were found to consume units above the averages of Canadian wonder and "Soya" bean varieties respectively . It should be noted that, part of the harvests is sold, saved for seed and sometimes given to friends and relatives. As far as SUA 90 variety is concerned, these other needs were covered by only 13 percent of the harvests of the SUA 90 growers (i.e both adopters and non adopters).

Results also show that 67.4 percent of the respondents were concerned with palatability out of which only 2.6 percent were negative. About 10.5 percent were concerned with broth quality, with 5.5 percent commenting negatively. Very few respondents were concerned with colour and seed size (these formed 3.5 percent and 6.4 percent respectively). Comments about seed size and colour were all negative. Majority of both men and women were concerned with cooking time and keeping quality of both dry and cooked seeds. The percentages were 65.1 and 11.6 respectively. In relation to consumption, it appears that the majority of farmers are concerned more with taste and palatability than the other factors. In this respect SUA 90 scored highly and was preferred by farmers (in comparison to the other varieties they grow).

Empirical results show that household size, perception on seed colour, seed size and keeping quality are not statistically significant in explaining the variation in the consumption of SUA 90 bean variety while amounts of local varieties consumed and farmer's perception on palatability and cooking time are highly significant in influencing the consumption level of the variety. Other influential factors include; the yield of SUA 90 bean variety. yield of local varieties, area planted with SUA 90, amount of SUA 90 seed sold and amount of local varieties and perception on the quality of broth.

The findings suggest that SUA 90 variety was consumed together with other local varieties in the household. It is possible however that more but more of the variety was consumed mainly because most farmers could not sell or indeed harvest enough for food and cash. However, the general indication is that the variety is preferred in terms of taste and palatability. Further more, there is a clear indication from farmers that the variety is superior to local varieties in terms of short cooking time.

5.3 Study Recommendations

This section responds to the fourth objective of the study. Based on the results and findings of the study, the following recommendations are made:

1 The Tanzania Bean CRSP Project should design and establish linkages with NGOs and other institutions working in the rural areas to ensure adequate and timely supply of SUA 90 seed and other technologies developed by the project. Such linkages and mechanism are presently lacking.

2 More effort should be channelled towards the multiplication of SUA 90 seed etc. to satisfy the farmer's demand for this variety. Currently the supply of the seed in rural and peri-urban areas is quite limited.

3. The project should continue and put more emphasis on the involvement of farmers in the project's breeding programmes for generation of better and more acceptable technologies. This could in future even minimize the necessity of conducting intensive adoption and impact studies because farmer's views and opinions would, to a large extent, be reflected in the released varieties.

4. The project should institute a permanent system of continuous follow up to the adoption and diffusion of the technologies. In addition, it is felt that a follow up study after 3 to 5 seasons will be more revealing on the adoption process and impacts of the introduced project technologies. This study had some relatively intensive data only for two seasons (i.e 1994/95 and 1995/96). Consequently more impact revealing coefficients such as the rate of economic returns (ROR) and a diffusion curve have not been estimated / estabilished.

5. The project should put in more efforts in advertising /promotion of technologies released. Feedback from this study suggests for example that not many farmers are aware of NITROSUA or EP4-4 which are the other major technologies developed by the project.

6. A market promotion strategy is recommended for the technologies so as to establish the market demand.

5.4 Areas for Further Research

The study assessed the impact and effects of developed technologies to small holder farmers. The study has achieved to demonstrate the early adoption rate and farmers' preference on the consumption qualities of SUA 90 bean variety. However the accuracy of the data was affected by various factors mentioned in section 3.6.4. Similar studies are proposed which will take care of the mentioned factors so as to come up with additional valuable information and findings.

In order to overcome the effect of the farmers obvious interview fatigue (e.g in areas where many projects/research activities have been implemented) on this study's findings, a similar study is proposed in areas where SUA 90 bean variety has been introduced but relatively few research activities have been conducted.

To overcome the effect of unfavourable weather a similar study is proposed with a longer duration to cover several seasons eg four. This will help farmers to have better and enough time for yield comparisons and tolerance assessment.

For better impact assessment and results of adoption studies, the limitation of data due to farmer's poor memory recall should be overcome by conducting continuous monitoring studies. Interviews should be done at each stage of crop growth (e.g during planting, plant growth, harvesting, eating etc.). These preferably should be for more than two consecutive crop seasons.

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Appendix A
SOKOINE UNIVERSITY OF AGRICULTURE
FACULTY OF AGRICULTURE
DEPT. OF AGRIC. ECONOMICS AND AGRIBUSINESS

TITLE: A Farm Level Impact Assessment of the SUA Bean Project Technologies.

FARMER'S QUESTIONNAIRE:

A. GENERAL INFORMATION

A1. Name of farmer............................

A2. Age of the respondent.............

A3. Village.....(1=Kisanga, 2=Msolwa, 3=Ulaya, 4=Dumila, 5=Magole, 6=Kinole, 7=Mgeta)

A4. District.....(1=Kilosa, 2=Morogoro Rural)

A5. Sex........ (1=Male, 2=Female)

A6. Marital Status......(1=married, 2=Single, 3=Widowed, 4=Divorced)

A7. Household size........No. of males...... No. of females......

A8. Age of household members.
- i) members with age below 20 years..........
- ii) members with age between 20 and 30 years,........
- iii) members with age betweem 30 and 40 years,.......
- iv) members with age between 40 and 60 years,.......
- v) members with age above 60 years............

A9. What is your education level? ......
- 1=None
- 2=Adult education,
- 3=Primary education
- 4=Secondary education and above

B. CROP PRODUCTION

B1. How did you acquire the land?......
- 1= Inherited, 2=Bought, 3=Hired, 4=Offered, 5=Cleared land

B2. What is the number of your farm plots?.......

B3. What is the total acreage of plots?.......

B4. What is the acreage for bean crop for the past four years/seasons?.......
1995.........
1994.........
1993.........
1992.........

B5. What is your main crop?.......
1= Beans, 2=maize, 3=rice, 4=bananas, 5= tomatoes, 6=others (specify).

B6. Why this particular crop? ....

B7. Apart from the main crop mentioned above, what other crops do you cultivate in your farm?

Crop	Plot size (acre)	Yield from last season	Sold/ not sold 1=sold, 2=not sold
1. Maize	....	....	....
2. Beans	....	....	....
3. Rice	....	....	
4. Bananas	....	....	....
5. Potatoes	....	....	....
6. Sugarcane			....

B8.Can you estimate the average income obtained from selling the crops mentioned above (refer last season)?
1= below 10,000/=
2= 10,000 - 50.000/=
3= 50,000 - 100,000/=
4= 100,000 - 150,000/=
5= 150.000 - 200,000/=
6= above 200,000/=

B9. What is your main source of labour?
1= Family labour
2= Hired labour
3= Both(a) and (b)

B10. Do you use the following in your farm?
i) tractor..... 1=yes, 2=No
ii) ox-plough..... 1=yes, 2=No
iii) hand hoe..... 1=yes, 2=No

B11. From question (B10) above, if using either of the two, do you own or hire

	1=Hire	2=own	3=Both
Tractor	....	....	....
Ox-plough	....	....	....

B12. Do you use the following in your crop production?
i) Fertilizer (chemical)..... 1= Yes, 2=No
ii) Pesticides..... 1= Yes, 2=No
iii)Irrigation...... 1=Yes, 2=No

B13. If using (i) and (ii) above where do you get them?
1= Buying from private shops
2= Cooperative Union
3= Extension officer
4= Friends
5= Others specify) ....

B14. Do you have any access to credit facility?...... 1=Yes, 2=No

B15. If yes, where?.......
1= NBC
2= CRDB
3= Cooperative Union
4= Informal lender
5= Others (specify) ....

B16. If no. why?.........
1=Not available
2=Not interested
3=Never thought of that
4=High risk/afraid
5=Other reasons (specify)......

B17. Do you have contacts with the village extension workers? .... 1=Yes 2=No

B18. If yes, can you estimate the average number of contacts you have had with the VEO per season? ....

1= Once per season
2= 2 - 3 times
3= 4 - 5 times
4= More than 5 times.

B19. How do you contact the VEO's? ....

1= They visit at their own time
2= Farmer calls them when in need
3= They have specific time/place to meet farmers
4= They are available any how.
5= Other means (specify).

B20. What type of advices do you get from the VEO's? ....

1= on disease problems
2= on land preparation
3= on crop management
4= on storage issues
5= on marketing issues
6= others (specify)

C. BEAN PRODUCTION AND ADOPTION OF SUA BEAN TECHNOLOGIES.

C1. Do you know anything about the SUA Bean Project?..... 1=Yes, 2=No

C2. What been varieties do you know?

1= SUA 90 .... 1=yes, 2=no
2= Lyamungu 85..... 1=yes, 2=no
3= Canadian Wonder..... 1=yes, 2=no
4= Kabanima .... 1=yes . 2=no
5= Soya .... 1=yes, 2=no
6= Masai red ..... 1=yes, 2=no
7= EP4-4 ...... 1=yes, 2=no

C3. Which one of these did you grow in your farm last season? ....
(use the variety codes above)

Variety (code No.)	Plot size	Yield
i).........	....	....
ii).........	....	....
iii)........	....	....
iv).........	....	....
v)...........	....	....

C4. Why did you grow these varieties?
(use variety codes above)
Variety (i)..........
Variety (ii) ....
Variety (iii) ....
Variety (iv)...........
Variety (v) ....

C5. From whom did you learn about each of the above varieties?
(stick to the variety codes)
1................. a. Fellow farmers
2................ b. Extension worker
3............... c. Mass media
4................ d. Bean Project workers
5................. (You may select more than once)

C6. Where did you get the seeds for each of the above variety for the last season? ......
1= saved from the previous harvests
2= private sellers
3= cooperative union
4= extension officer
5= SUA Bean project
6= friends/relatives/neighbours
7= Others (specify) ....

C7. Which technologies introduced by the SUA Bean Project do you know?
say yes or no (1=yes, 2=no)
1= SUA 90 bean variety ......
2= EP4-4 bean variety ......
3= NITROSUA ....

C8. From the answer(s) in (C7) above, which one(s) did you use/adopt in the previous bean crop?

i) adopted No.1?...... 1=yes, 2=No
ii) adopted No.2?....... 1=yes, 2=no
iii) adopted No.3?...... 1=yes, 2=no

C9. Why did you adopt the above mentioned technologies.

1= increase yield
2= easily managed in the farm
3= less affected by diseases
4= cheap in use (cost saving)
5= stable to weather cheanges
6= easy to store
7= good to consume
8= other reasons (mention) ....

C10. How do you compare the technologies introduced by the project to those used before?.................

1= Excellent, 2= Very good, 3= Satisfactory, 4= Bad, 5= Very bad.

C11. Why?.......

C12. For how many years have grown SUA 90 variety?........

C13. For how long have you been in bean production?

1= Less than a year
2= 1 - 5 years
3= 5 - 10 years
4= More than 10 years

C14. Did you stop producing any crop or bean variety in favour of

i) SUA 90 bean variety?...... 1=Yes, 2=No
ii) EP4-4 bean variety? ..... 1= yes, 2= No

C15. If yes, which crop(s) did you switch from?...........

1= maize
2= Local bean varieties
3= bananas
4= rice
5= others (specify)

C16. Did you reduce a plot size of any crop to increase the bean plot size? .. 1=Yes, 2=No.

C17. How much land was increased/reduced?..........acres.

C18. Why do you grow beans?
1= Family consumption
2= For sale
3= Both
4= Other reasons (specify)

C19. If for sale, where did you sell for the last season?
(use variety code Nos. to specify type of variety sold to each buyer)

Buyer	Variety	Amount sold
i) local middlemen	....	....
	....	....
ii) local markets	....	....
	....	....
iii) urban markets	....	....
	....	....

C20. How many times do you grow beans in a year?.....
1= Once
2= Twice

C21. What are the planting and harvesting dates.
Planting ....
Harvesting ....

C22. What are the amount. types and costs of the inputs used in growing beans and other crops? (Use the code Nos. below the table to fill in;)

Crop	Type of input	Amount used	Cost incurred
Bean varieties from SUA			
1. SUA 90			
2. EP4-4			
Local varieties			
1.			
2.			
3.			
4.			
Other crops			
1.			
2.			
3.			
4.			
5.			

* For local varieties: 2=Lyamungu 85, 3= Canadian wonder, 4=Kabanima, 5=Soya, 6=masai red, 7=others.

* For other crops: 1=maize, 2= beans, 3=rice, 4=bananas, 5=sugarcane, 6=others.

* For Type of input used: 1= fertilizer (chemical), 2= pesticide, 3=irrigation, 4= labour. 5=tractor, 6=oxen, 7=seeds

D. CONSUMPTION OF BEANS

D1. How often do your family consume beans.

1= Very often
2= Occasionally
3= Never consume

D2. State reasons for your choice in D1

i)............................
ii) ....
iii) ....
iv)............................

D3. Where do you get beans for household consumption?

1= Family farm
2= Market
3= Both (a) and (b)
4= Friends and relatives
5= other sources (specify)

D4. Which variety and how much of each was consumed from the last season?
(use the variety and source of beans codes from questions C2. and D3 respectively)

Variety	Amount consumed	Source of beans
i).............	....	....
ii)............	....	....
iii)...........	....	....
iv)............	....	....
v)..............	....	....

D5. Was the amount kept from the previous harvest sustain the family to the next harvest?..... 1=Yes, 2=No

D6. How would you compare the consumption of bean varieties

1= Improved varieties from SUA Bean Project were consumed more
2= Local varieties were consumed more
3= Both were equally consumed
4= None were consumed

D7. State the reason(s) for your choice in D6.

(a).................................
(b).................................
(c).................................
(d)................................

D8. Specifically what comment can you give in relation to consumption of SUA 90 and EP4-4 varieties?

a) Positive......................................
....
....

a) Negative ....
....
....

D9. What type of menu does your family prefer mostly to have with SUA 90 bean varieties?
1= Ugali, 2= Rice, 3= Bananas, 4= Potatoes, 5= Others (specify)

D10. Following the decision to consume SUA 90 or EP4-4 bean varieties, has your family sacrificed or reduced meat consumption in favour of beans? ..... 1=Yes, 2=No.

D11. If yes, why?..........

D12. Can you sense any difference in fuel consumption when cooking the SUA varieties as compared to the other varieties? ..... 1=Yes, 2=No

D13. If yes, what is the difference?
1= they consume less fuel, 2= they consume much more fuel

E. GENERAL QUESTIONS

E1. Among the technologies developed by the SUA Bean Project which ones are labour saving? (use the technology codes in QS. C7)

i)............, ii)..........., iii)..........., iv)............,

E2. Is the labour saved used in other productive role? ...... 1=Yes, 2=No

E3. If yes which roles? ....
1= cultivation of other crops
2= livestock keeping
3= petty business duties
4= Others (specify)

E4. Did you store any beans from the pervious harvests? ..... 1=Yes. 2=No

E5. If yes, which storage methods did you use? ....
1= chemicals - eg rodenticide
2= traditional methods - eg kihenge. ash,plant residues,cow dung etc.
3= improved traditional methods - eg improved kihenge
4= modern structures - eg concrete store with iron sheets
5= others (specify).

E6. From whom did you learn about the storage methods?
1= Extension workers
2= Fellow farmers
3= SUA Bean Project Workers
4= Mass media
5= others (specify)

E7. Have you been taught any storage methods of beans from SUA Yes/No
If yes, what are they?

i)................ ii)................
iii)............... iv)................
v)................. vii)..............

E8. What problems did you face in the storage of beans?

Variety (use codes) Problem

i)................... ....
ii).................. ....
iii)................. ....
iv).................. ....
(problem codes, 1=roddent, 2=storage pests, 3=others (specify)

E9. What was the retail price of beans of the last harvests?
Variety (use codes) Price (Tshs)
i).................... ....
ii)................... ....
iii).................. ....
iv)................... ....

E10. What was the price of other crops produced by your household

Crop (use codes)	Prices
i)...................	....
ii)...................	....
iii)..................	....
iv)...................	....

F: BEAN FARMING PROBLEMS

F1. Are there any other problems faced in the production of beans in the last season? 1=Yes, 2=No

F2. If yes, what are the problems
i)............ ii).......... iii).......... iv).......... v)..........
(1=seed availability, 2=diseases and pests, 3=unfavourable weather, 4=market problems, 5=land availability, 6=others (specify)

F3. What measures did you take to combat them?
i)...
ii)...
iii)...
iv)...
v)...

F4. Did you get any advice from the extension workers concerning these problems? 1=Yes, 2=No

F5. If yes, what advice did you get
i)..........., ii)............, iii)..........., iv)..........., v)...........,
(1=use of pesticides, 2=seed saving from each harvest, 3=irrigation, 4=use of improved varieties, 5=others (specify)).

F6. If no, why?
i)............., ii)............, iii)............, iv)............, v).............,
(1=there is nothing that they could do, 2=they were not available for advice,3=I didn't contact them, 4=others (specify).

F7. Have you attended any training on the use of new technologies?....1=Yes, 1=No

F8. If yes, how many times....., What did you learn?
i)..............., ii).........., iii).........., iv).........., v)..........,
(1=new/different bean varieties, 2=about bean crop management, 3=about storage of
beans, 4=others (specify)

F9. Do you have any comments on the introduced SUA Bean Project varieties and technologies?.... 1=Yes, 2=No

F10. If yes, comment:.................................
....
....

F11. Are you ready to continue/start planting the SUA Bean varieties and use the introduced technologies ...... 1=Yes, 2=No.

F12. Why?...
....
....

Best wishes and Thank you

Vera F.J. Mkenda

Appendix B

SOKOINE UNIVERSITY OF AGRICULTURE
MSc. AGRICULTURAL ECONOMICS RESEARCH
BEAN FARMER'S QUESTIONNAIRE (2nd season's report).

Tittle: A Farm Level Impact Assessment of the Tanzania Bean CRSP Project.

1. Did you plant SUA 90 variety this season? 1=Yes 0=No

2. Why?..............................
   ....
   ....

3. What was the acreage for SUA 90 variety? (this season)........ acres OR What was the amount planted (in kg) ....

4. From the previous harvest, did you distribute/give SUA 90 seed to anybody? 1=Yes 0=No

5. If yes, to how many?......
   (i) By selling .... (write the number of people distributed)

   What was the price? .... Tshs.

   (ii) Freely? ....