ADDIS ABABA UNIVERSITY

SHOOL OF GRADUATE STUDIES

# THE IMPACT OF AGRICULTURAL EXTENSION ON *MAIZE PRODUCTION*: A CASE STUDY OF SASAKAWA GLOBAL-2000 EXTENSION PROJECT IN BAKO AREA

*By Beyene Tadesse*



*June, 1998*

Adiss Ababa

*To my children*

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*By Beyene Tadesse*

A THEIS

In partial fulfilment of the requirements for the Masters of Science degree (Economic Policy Analysis).

*June, 1998*

Adiss Ababa

**ADDIS ABABA UNIVERSITY**
**School of Graduate Studies**

*The Impact of Agricultural Extension on Maize Production: A Case Study of Sasakawa Global-2000 Extension Project in Bako Area*

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# ABSTRACT

*The SG 2000 extension project has been disseminating improved maize technologies, among others, to achieve its objective of improving farm productivity and thereby increasing food grain production. However, the SG 2000 project may not be special to weakness and constraints that the previous extension approaches were faced with. Thus, this thesis has attempted to identify determinants of extension participation, and to evaluate the impact of the SG 2000 extension project on maize production by examining the level of awareness, adoption, and the increment in productivity and profitability attained using the improved maize production in the Bako area. The Probit model and the Two-Stage Switching Regression approach were employed in the analysis using data collected from 225 sample farm households.*

*It has been found out that proximity to the main road, number of oxen owned, total farm size owned, education level of the household head and availability of credit for down payment significantly affected farmers decision to participate in the SG 2000 extension activities. Significantly high number of both the extension participant and non-participant sample farmers have been aware of the improved maize technologies. However, while almost all the sample extension participating farmers adopted the improved maize technologies, only 10% of the sample non-extension participating farmers adopted. The analysis showed that using the improved maize technologies is much more productive as indicated by the higher elasticity coefficients and the marginal products of the inputs. The increment in productivity (gross benefit) resulted from the extension program has been estimated to be 37.25 quintals of grain maize per hectare. Considering different scenarios of cost for the improved practices the net benefit for the SG ranges from 726.46 to 1267.48 Birr per hectare, and accordingly the MRR ranges from 36% to 213%. On the other hand, the net benefit for the NSG from the traditional practices is only 385.60 Birr per hectare.*

*Nevertheless, many technical and policy problems have been identified affecting the sustainability of the adoption and the incremental productivity of the improved maize technologies. Therefore, the use of the improved maize technologies and the net benefit exhibited by the adopters may be for the short-run and/or may be limited to benefit only few farmers. Thus, the challenge remains with how to accelerate the adoption and maintain the* *productivity level of the improved maize technologies on a sustainable base. In this regard, subsidizing and facilitating credit services, output price support, encouraging intra-regional trade, improving input supply, promoting the development of infrastructure and encouraging further research to develop streams of improved seeds are suggested.*

# CHAPTER I

## 1.1. INTRODUCTION

There is an increasing recognition that the potential for increasing agricultural output and improving the life of the rural population lies in raising the productivity of existing resources. In this regard, rapidly growing agricultural productivity is taken as one of the main strategies for development in many developing countries. However, this strategy cannot be effective in the absence of new or improved agricultural technologies because of the existence of a significant gap between known and feasible agricultural practices and the actual practices of the majority of farmers (Schultz T.W, 1964, Patil, and Dayanatha, 1978). One attempt to close the gap has been to introduce programs that focus primarily on the delivery of physical inputs such as fertilizer, improved seeds or high yielding varieties (HYV), and improving farming cultural practices of farmers.

Hence, agricultural extension has been given high priority in the dissemination of improved technologies to farmers so that they become efficient users of resources. The adoption of improved technologies by farmers is believed to result in higher income for adopters, and lower real price of agricultural products for consumers, and greater economic efficiency and growth in a national economy. Experience shows that new technologies (improved varieties, fertilizer, agronomic practices, etc.) have increased production to unprecedented levels. The adoption of these technologies has resulted in significant income increases of the adopters compared to the non-adopters. But the benefit from technology adoption largely depends upon socioeconomic factors facing the farmers (Itana, 1985; Chilot, et al, 1996; Mulugeta, 1995 and Getachew, et al, 1995) and the strategies and design of extension services (Gershon, et al, 1985).

In Ethiopia, as noted by Tennassie (1985), agricultural extension has been poorly performing. To some extent this has been due to lack of conviction regarding the ability of extension to bring about the sharp increase in agricultural productivity heralded by the growing quantity of new modified technologies emerging from the Institute of Agricultural Research (IAR). The introduction of improved agricultural technologies was started with the establishment of IAR, and efforts have been made since then to diffuse and transfer them to producers. Different extension systems have been exercised by the Ministry of Agriculture (MOA), Non-government organizations and Research-Extension Department of the Research Centers of the IAR. But adoption studies made at different levels in different locations indicate that technology transfer and adoption by farmers are highly constrained by external and internal problems. As a result no significant change in farmers income could be perceived (Tennassie, 1985).

The Five-year Development Plan of the Government (EPRDF, 1996), puts special emphasizes on the development of the agricultural sector. Structural changes have been effected to transform traditional low productivity agriculture into high productivity agriculture, and to provide enough income to the rural people. Accordingly, increasing attention has been given to ways of improving the management and efficiency of the extension system.

Sasakawa-Global 2000 (SG-2000) extension project has been introduced to help small scale farmers to increase their agricultural food production through an aggressive technology transfer using the extension services of the MOA. In effect, the Government of Ethiopia has shown its appreciation for this program and has decided to accept its full implementation (Meles Zenawi, 1996).

## 1.2 STATEMENT OF THE PROBLEM

The ultimate goal of the extension project is to improve the welfare of the citizens of the country. This goal is achieved by, among others things, increasing productivity at farm level and farmers' income. This is possible if and only if improved technologies are properly transferred to the users in a scientific and acceptable approach so as to induce adoption.

The National Agricultural Research Centers have been successful in developing high yielding varieties particularly of maize, wheat and sorghum with recommended fertilizer and other agronomic practices. But most of them were shelved because of socioeconomic and extension policy problems. The SG_2000 project with its special approach is expected to make use of the fruits of the research centers more effectively and to have greater economic rewards to maize producing communities.

Moreover, since 1996 the MOA has ambitiously been attempting to follow in the footsteps of SG-2000 by adopting the SG-2000 approach. Thus, the Government has launched the technology diffusion process over the whole country without proper evaluation of the actual impact of the SG 2000 extension on the farming community. The SG-2000 project may not be immune from the weakness and constraints that Ethiopia had experienced in the previous extension systems. Thus, given that the SG-2000 extension system involves considerable costs the program can only be justified if it can increase technology adoption and farm productivity.

So far, no rigorous study has been conducted on the effects of the SG 2000 extension system. Thus, feasible changes in the technology adoption and subsequent impacts of the project on farm households income need to be investigated and quantified. It is also necessary to evaluate technical, socioeconomic and policy related problems facing the farmers that may hinder the sustainability of the project motives.

## 1.3 OBJECTIVES OF THE STUDY

The objective of the study is to evaluate the impact of SG-2000 extension project in its effort to transfer maize technologies to the communities involved. More specifically, the study aims:

1. to assess the level of awareness and adoption of improved maize technologies transferred by the project by extension participation.
2. to estimate the incremental productivity effect which can be attributed to SG-2000 extension project over the traditional production practice.
3. to assess technical, institutional and policy related problems encountered by the farmers, and then to suggest possible recommendations.

The main hypothesis is that the SG 2000 extension project has significant impact on productivity of maize for farmers who were participating in the extension program and/or adopted the recommended farming practices.

## 1.4. SIGNIFICANCE OF THE STUDY

In any agriculture based economy, the development initiation seems likely to be frustrated if the small farmers are not provided with the means for increasing their productivity, income and thereby their standard of living. This would be of paramount importance when it comes to maize growing farmers as well since many households depend on maize. Therefore, any development program needs to be thoroughly evaluated whether it has contributed tangible improvements in the living condition of farmers or not.

An important requirement for the project management as well as the hosting nation is to be kept informed on whether the project has achieved its goals. Information from evaluation studies enables extension administrators and agents to learn more effectively from their experience either to encourage or redesign more effective extension programs, and to formulate appropriate policies, thus causing some gradual change in the image of reality. Information from impact analysis could help to know the relevance, effect and consequences of activities.

## 1.5 SCOPE OF THE STUDY

This is a micro level study limited to Bako area. Moreover, it was based on only about 200 randomly selected households from the specified area. On the other hand, Ethiopia has a wide variation in agroecological and socioeconomic conditions. Therefore, it is difficult to make generalizations from studies made in such small area. However, the area selected for the study is representative for most maize growing areas in the country. Hence, it is hoped that the result could be applicable to some locations having similar circumstances. The study approach would draw a priori knowledge of how the agricultural sector functions, and an empirical knowledge of the actual effect of the SG 2000 extension on the farming households.

## 1.6 LIMITATIONS OF THE STUDY

While dealing with farm household study, availability and precision of data is always a problem. The study has also been faced with limitations in this regard. Farm areas estimated in local unit, "oolsha", was converted into hectare that may have some measurement errors. Maize output for the extension participants were directly measured. But, those for the non-participants were collected from interviewing individual farmers. However, farm areas and yield data reported by the farmers were checked against the secondary data, and irrelevant figures were omitted from the analyses.

Beyond the principal objective, increasing productivity, technology adoption can have other impacts, positive or negative. Technology adoption can possibly affect income distribution, nutrition, employment and the environment. The intensity of these effects, and the sustainability of the project results would largely depend on the country's economic policies. However, the paper would not go into the quantitative analysis and detail discussion of these all aspects. Nevertheless, the study provides substantial information on the gains resulted from the SG 2000 extension project at the farm-level.

# CHAPTER II

# BACKGROUND TO THE STUDY

## 2.1 A SUMMARY OF THE ETHIOPIAN EXPERIENCES IN AGRICULTURAL EXTENSION

A brief summary of the extension systems that have been introduced in Ethiopia would help to reflect on our past experiences and look forward in prospective. Different extension approaches have been practiced since 1967. Some of them are briefly shortly discussed below.

### 2.1.1 The Integrated (Comprehensive) Rural Development Approach

The theoretical foundation of Integrated Rural Development was the high-pay off input model. The first such project was initiated by the Ethio-Swedish project at Chillalo, Arsi, as "Chillalo Agricultural Development Project "(CADU) (1967). The integrated project consisted several components (rural road construction, potable water supply, research, crops and livestock extension, input distribution, marketing, cooperatives, etc.). More than any other project, CADU later named as ARDU, has had lasting impact on several counts (skill development at lower, middle and professional levels, grass-root studies, dissemination of fertilizer and improved seeds, improved dairy cattle, farmers training, several penetration rural roads, etc.).

The Wollamo Agricultural Development Project (WADU) (1970) was also designed as integrated intensive program to provide farm input, infrastructure, and extension services in densely populated highland areas of Wollamo District of the then Sidamo Region (Cohen, 1974). The extension service aimed at improved crop production through provision of, among others, land planning and soil conservation, agricultural credit (in cash and kind), improved seed, fertilizer and improved farm implements. The program used the demonstration field to extend the improved technologies.

In both CADU and WADU projects, farmers had enthusiastic response to improved farm inputs. Thus, the projects had shown that farmers adopt improved technologies provided that necessary services are available. But the land tenure situation in Ethiopia in those days had presented a sever constraint on the attempt of the projects to benefit the small farmers in the target areas. The benefit accrued to the peasants was at best marginal. There were also several evictions of tenants and small holders. Hence, the projects were strongly criticized as creating rural elites (income disparity). They were also considered costly both financially and in terms of manpower requirements, and unsustainable in the long-term (Lele, undated)

### 2.1.2 The Minimum Package Program (MPP) Approach

The MPP approach was initiated in 1971 and emanated from the integrated rural development approach. The basic approach was to offer farmers an integrated "minimum" of advises on what inputs to use and how to use them. The package consisted of inputs (fertilizer, improved seed, pesticides, etc), livestock (dairy, poultry, etc) credit facilities, marketing, cooperation, etc. Trial and demonstration of innovations to farmers were carried out.

However, like the integrated program, the MPP activities were also hindered by the land tenure system of the period. The program was tailored for resource-rich peasants who were able to provide collateral. The program never met the needs of small scale farmers because they were unable to participate in the program, and if at all they do they could get only a small margin of the profit. It could be concluded, here too, that the MPP did not benefit the small holder rural peasants. Therefore, increases in production and the general process of change had been hampered (Cohen John, 1974).

### 2.1.3 The Peasant Association Development and Extension Project (PADEP)

Basically PADEP was developed to support the peasant sector in providing with improved input supply and distribution especially fertilizer, improved seed and farm chemicals. It stressed the development of service cooperation to strengthening extension service. An integrated program of adaptive research aimed at formulating a set of extension package in different regions was undertaken. Under PADEP, the extension approach was, influenced by the World Bank based on the general concept of "Training and Visit" (T & V) system which aims at bringing behavioral changes through intensive local communication and visit by extension agents. The extension agents were demonstrating improved technological packages to farmers, and were assisting in proper supply of the necessary inputs. The extension agents were also responsible to train farmers and to give advice on post-harvest handling of crop (IBRD/IDA, 1974). However, PADEP was also poorly implemented. Some of the major problems were insufficient extension man power, inadequate budgetary allocation, and multifarious duties given to extension agents reducing time available to disseminate information. As a result, very little seems to have been achieved in the form of technology transfer.

Tennassie (1985), in his study of Agricultural Research and Extension in Ethiopia, has clearly stated that both external and internal weaknesses as a major causes attributed to the failure of those extension programs to success. He mentioned inappropriate design of the programs and very poor research and extension linkages as the external weaknesses. Whereas, unfavorable ratio of development agents to farmers, inadequate training of agents, poor motivation of staff, and absence of senior extension specialist and communication experts are the internal weaknesses from which Agricultural extension of Ethiopia was suffering. Another study by Beyene, et al, (1991) in Bako area also indicated that cash availability, inadequate and late delivery of input components, and insufficient credit and poor extension system were the major limiting factors for maize technology transfer and adoption.

Unfortunately the Ethiopian peasant in general and the small scale farmers in particular, did not benefit much from the program in terms of increasing agricultural production and productivity. The SG_2000 extension project has been initiated to alleviate at least some of the problems observed in the previous extension approaches.

## 2.2 AN OVERVIEW OF THE SG 2000 EXTENSION PROJECT

The SG 2000 project has been initiated by two humanitarian organizations, the Sasakawa Africa Association (whose president is Dr. Norman Borlaug, an agricultural scientist and Noble Peace Prize Laureate) and Global 2000 of the Carter Centre (chaired by Jimmy Carter, the former president of USA). Funding for the project comes primarily from the Nippon Foundation of Japan whose chairman is the late Ryoichi Sasakawa. The main mandate of the project is to enhance food security by introducing appropriate technologies to small scale farmers.

In 1986, the first SG-2000 project began working with farmers in selected Sub-Saharan African countries to solve the problem of declining per capita food production. The belief has been that farmers should use modern research information and higher input level to produce more food.

The project is also based on the assumption that there exists sufficient proven technologies to increase crop yields that can be used by small-scale farmers.

### 2.2.1 Objectives and Organizational Structure of the SG 2000 in Ethiopia



**a)** ***The Project Objectives***

The SG-2000 project was initiated in Ethiopia in 1993 with the overall objective of assisting the country to increase its food grain production rapidly (Quinones and Takele, 1996). The specific objectives of the project are as follows:

* Disseminate improved production technologies to small-scale farmers through the extension services of the MOA.
* Strengthen the capacity of the extension services of MOA.
* Assist in the creation of a functional linkage between agricultural research and extension systems in the country.
* Initiate a strong extension program in post-harvest and food grain processing technology.
* Offer the Government of Ethiopia the capacity of the Carter Centre in fostering sound agricultural policies for sustainable development.

**b)** ***Organizational Structure***

The SG 2000 program has only few staffs. The program is led by Dr. Marco Quinones, a Mexican crop scientist, together with one senior program coordinator. In addition SG 2000 has employed three Ethiopians as technical staffs (two post-harvest experts and one senior technical staff). It has also one administration and finance manager.

The National Extension Service assigns seven senior professionals to work closely with SG 2000 in program designing, implementation and follow-up. The key extension staff are head of the Extension and Cooperative Promotion Department, and National Extension Team Leader. In addition, it has one program coordinator at each zonal and district MOA offices.

The SG 2000 project works primarily, in close cooperation with the MOA to mount dynamic and extensive technology transfer campaign. The Ministry's regional and district offices play key roles in implementing the project particularly in selecting locations for project sites and farmers within villages, and are fully responsible to advice farmers and follow up the demonstration plots. The project supports MOA in several forms that include advice, supplementing budgets for extension services, supplying vehicles, training, regular orientations and frequent field visits.

### 2.2.2 The SG 2000 Technology Transfer (diffusion) Mechanism and Its Difference From the Traditional MOA System

#### a) *Demonstration on Farmers' Field*

Field demonstration programs have been started with some of the most important food crops such as maize, wheat, sorghum and tef for which proven and markedly superior technology is available. The centerpiece of the SG 2000 project strategy is the farmer managed technology evaluation and training plot, sometimes called as the Extension Management Training Plot

(EMTP). EMTP is a small plot of land on the farmers' own farm land and is managed by the farmers themselves. It is used by the extensionists to demonstrate the proposed technologies. The project uses EMPTs as the principal extension tools for exchanging and transferring information to farmers. The area of EMTP is usually about 0.5 ha. This is hoped to be large enough for the farmers to assess clearly the labour and other input requirements of the recommended technology. Moreover, with this large size, the farmers also get immediate and clear measurable benefits. Using large plots also helps to show policy-makers, administrators, and private sectors the potential and the needs of improved technology (SG 2000, 1996).

**Table 1: Distribution of EMTPs by Region and Crops (1993_1995).**

| Region | Crop | EMTPs (Number) | | |
|---|---|---|---|---|
| | | 1993 | 1994 | 1995 |
| Oromia | maize | 60 | 461 | 1126 |
| | wheat | 63 | 462 | 808 |
| | teff | __ | 20 | 90 |
| | sorghum | __ | __ | 40 |
| Southern | maize | 38 | 317 | 546 |
| | wheat | __ | 41 | 67 |
| | sorghum | __ | __ | 5 |
| Amhara | maize | __ | __ | 60 |
| | wheat | | 125 | 221 |
| | teff | __ | __ | 45 |
| | sorghum | __ | 8 | 30 |
| Tigray | maize | __ | 20 | 63 |
| | wheat | __ | 10 | 40 |
| | teff | __ | __ | 40 |
| | sorghum | __ | 10 | 39 |
| Total | | 161 | 1474 | 3211 |

*Source: SG 2000 Annual Report, 1996*

The participating farmers as well as the neighbours who have observed the technology and the results, are expected to continue using the new practice until the majority of the farmers are adopting the production system. That means, the process motivates the farmers to adopt the technology on continuing basis. This process is assumed to have an important multiplier effect.

Conversely, the extension services of MOA were using very small plots (10m*10m) and were managed by extension agents who would invite farmers to learn by observing the results attained. The demonstration plots were even located in very scattered areas (may be one in a region), and therefore were not accessible for the majority of farmers.

Table 1 summarizes the number of EMTPs undertaken by the SG-2000 extension over the years 1993 to 1995. The table depicts that many of the EMTPs have been in Oromia region, and the highest number of EMTPs in each year was on maize. In Oromia over 60% of maize EMTPs were concentrated in Bako area (SG 2000, 1996).

b) *In-service Training*

Although small-scale farmers are generally aware of improved seed, fertilizer and so forth, they often lack the detailed Knowledge to take full advantage of the improved farm inputs. For this reason, in-service training was given to front line extension workers, who in turn provide training to participating farmers. Accordingly, during the years from 1993 to 1995, 2501 extension staffs were trained. EMPT farmers as well as neighbours, generally get this training through an organized group, using the plots in the vicinity as the teaching site. Farmers who participate in the project field test and demonstration programs are assured that they will receive technical training and necessary inputs to put into practice the entire packages of recommended technology. However, such type of training arrangement is not commonly seen in MOA.

c) ***Credit Service***

Without some form of credit small farmers have little chance of increasing their production substantially . While an investment in improved seed or fertilizer will usually produce enough profit to pay back a loan, farmers cannot afford the switch to more productive but expensive techniques without an initial credit. Thus, the SG-2000 project gives inputs in the form of loans to the farmers (with 50% down payment) who agree to repay the debt after harvest. Therefore, credit provision to participating farmers for the purchase of inputs is another unique feature of the SG 2000 project.

d) ***Facilities and Technological Inputs***

*i) Transport:-* The SG 2000 has given due emphasis to improve the problem of transport facility that the MOA is faced with. Hence, it has supplied vehicles to the Extension Departments at central, regional and district level to facilitate the extension activities. Over the years from 1993 to 1995, the project provided 7 four wheel drive pick-up trucks for central, regional and zonal of MOA offices, 33 motor cycles for district extension supervisors, 186 bicycles for extension agents and 55 chemical sprayer for extension activities in the country as a whole (SG 2000, 1996).

*ii) Input supply*: The SG 2000 project empowers extension agents with necessary inputs to implement demonstration plots by purchasing improved seeds, fertilizer and agro-chemicals.

The inputs are available in a right amount at a right place and time; but this feature is rare in the MOA case. Most of improved varieties and crop management recommendations are based on the national and international agricultural research centers. Hence, the SG 2000 extension project uses location specific recommended technologies, while MOA usually uses blanket recommendation.

e) *Incentive*

The SG 2000 project offers award to the best farmers and extension staff to motivate them to work more. The project also provides some amount of money to supplement the normal salary of extensionists who are responsible to run the project; but this is totally absent in the case of MOA.

f) *Motivation*

The SG 2000, extension project motivate extensionists by providing them with facilities, incentives and technologies. They are expected to fully devote their time offering extension service to the farmers. However, in the MOA system extensionists are responsible for multifarious duties; and because they are faced with shortage of facilities and because of budgetary problems they lack motivation.

g) *Concentration of Extensionists*

The SG 2000 project has given a special focus on increasing the extension services in attempt to transfer the improved technologies to the farmers. To effectively impart knowledge and advice, the extension services were brought nearer to the farming community by placing field level extension workers in close proximity to farmers. As a result, there was relatively more active extension agents and higher extension farmer ratio in SG 2000 project working areas than that of the MOA[1].

**h)** ***Strong linkage with Research Institutes***

There was a strong communication between the SG 2000 project and the Institutes of Agricultural Research in and outside the country. The project reinforced Agricultural Research Centers of the country by providing vehicles and supplementary budget for on-farm research activities. The SG 2000 project had established an interface between research and extension through pre-seasonal workshops, monthly training programs and joint field visits.

The main similarity between the MOA and the SG 2000 projects is that the extension staffs who have been running both extension systems are the same people right from the head quarter up to local extension agents. Besides, the written objectives and the ultimate goals of both extension systems are more or less the same. However, the design and practical implementation of technology transfer mechanism is quite different as discussed above.

## 2.3. THE STUDY AREA

The study area includes part of West Shewa and part of East Wallaga regions and lies along the Addis Ababa-Nekemte road stretching from Jajji to Sire with 15 km to 20 km radius from the

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main asphaltite road. It is a mid altitude area (the elevation ranges from 1500 to 2000 m) that receives relatively high rainfall, 1217 mm. The rainfall is fairly reliable, with unimodal distribution pattern. The mean annual temperature is 28.4°c. The topography ranges from gently undulating slopes to hilly situation. The area includes four districts namely, Chaliya, Bako-Tibbe, Gobbu Sayo and Sire that covers the maize belt in those regions.

The main objective of the farmers in the area is to secure adequate family food supply and cash earnings for households through out the year. To meet this objective farmers grow different food and cash crops and keep livestock. The dominant crops grown are maize, tef, pepper, sorghum and `nug' in order of importance (Legesse, et al, 1986, and Beyene et al, 1991). All farmers grow maize mainly for food. However, due to its massive production maize also plays an important role in generating cash to the farmers (Legesse D., et al, 1986).

Maize has been chosen in this study to investigate the impact of technological changes in the study area mainly because the SG-2000 project has been working most intensively on this crop in the country as a whole and in the proposed study area in particular.

Bako is selected for the study primarily because the SG-2000 extension project was intensively implemented in this area.

This is indicated by the number of Extension Management Training Plot (EMPT). Maize demonstration plots constituted about 60% of the total demonstration plots in the country in 1993, 54% in 1994 and 56% in 1995 of which on the average over 36 % were concentrated in this area. Therefore, noting that the extension project devoted significant effort in Bako, and since maize is the dominant crop, this area has been chosen for the study.

# CHAPTER III

# REVIEW OF LITERATURE

## 3.1 THE CONCEPTUAL FOUNDATION OF AGRICULTURAL EXTENSION

### 3.1.1 Definitions of important terminologies.

**a)** ***New technology***

New technology/innovation includes ideas, methods or objects that are considered new for individuals (Van den Ban, et al, 1988). On the other hand, Roger (1983) defined new technology or innovation with respect to agriculture as the use of chemical fertilizer, insecticides, improved seeds, improved farm implements, new cultural practices, etc. which have not been used by the farmers before. The agricultural technologies can be introduced in packages (several components at a time) such as HYV, fertilizer and recommended agronomic practices, or independently. The components of these packages may complement each other.

**b)** ***Extension***

The meaning of the term `extension' is not well understood in the wider community except to people who work in extension organizations. There is no single accepted definition for the term. Different people define it differently. According to Neils (1988), extension is defined as an instrument for helping people make well considered choice among alternatives. The emphasis is on supporting individuals to make optimal decision with respect to achieving his/her own goals.

The individual is seen as free to use or not to use the extension. However, Neils also noted that in most countries extension is deployed, first of all, as an instrument to achieve policy goals such as national food security, food sufficiency, cheap food supplies, etc but not for helping individual farmers.

Van den Ban and Hawkins (1985) defined extension as transferring information, knowledge or technology or as promoting its utilization. Their definition emphasizes that extension service affect decision making and opinion formation through imparting external information and by restructuring available knowledge. On the other hand, the definition by FAO (1988) is restricted to farm activities. Here extension is defined as a service or a system which assists farm people, through an education process, in improving farming methods and techniques. Extension may also help farmers overcome barriers such as lack of motivation, information, knowledge, and resource which prevent them from achieving their goals.

Following the works of Neils's (1988), the different definitions of extension have some common elements. Extension is an intervention using communication as its instrument to induce changes. It can be effective only through voluntary base. And extension can be deployed by an institution, Governmental or Non-Governmental, and it requires professionals. When communication is ones instrument for inducing changes, extension impact is limited to inducing voluntary change (unless one has other derived source of power to force people into compliance). For this reason, the definition of extension stresses that the effectiveness of extension depends on the willingness of people to be persuaded or on the extent of which they see extension as serving their own interest and benefit.

*c) Technology Transfer (Diffusion) Process*

Technology transfer or usually named as diffusion is the human interaction in which one person communicates a new idea to another (Roger, 1983). And Neils (1988) defined diffusion process as the process of spread of new technologies. With regard to agriculture, it is the case when extension organizations spread/transfer agricultural technologies to farmers.



d) *Technology Adoption*

Roger (1983) defined adoption as farmers' decision that new practices or ideas are good enough for full-scale and continue to use. Therefore, according to him adoption is a mental process of individuals that passes five stages from first hearing of an innovation to final adoption.

These stages are: a) awareness:- learning and getting general information about technology b) interest:- a farmer develops an interest and wants more detailed information c) decision:- a farmer evaluates the information in the previous stages and determines to try it d) trial:- the farmer practices on a trial base, and e) adoption:- decision to use the new practice on continued bases. The time taken by an individual to adopt a new technology depends on his/her personal and/or household characteristics and the physical and socioeconomic constraints he/she is faced with. Rejection or discontinuity after trial of the new practice could occur due to failure of the new practice and/or socioeconomic constraints faced with farmers.

### 3.1.2 Theoretical Framework of Evaluation of Extension Impacts

The Ministry of Agriculture uses extension as one of its instrument to promote agricultural development, that is to increase agricultural production and/or productivity of land, labour and capital. Agricultural development is achieved if more production is attained with the same inputs of land, labour and capital for inputs are always scarce. The introduction of modern agricultural technology is one common method to achieve this objective. Therefore, the main function of agricultural extension is to communicate agricultural research findings and recommendations to farmers in the expectation that it will bring about changes in farm management (Evenson, 1986). Farmers are encouraged to develop high degree of independence in the decision making. Extension also backs information on problems and program achievements from farmers to extension organization, research institutes and policy makers (Van den Ban, 1986). In this manner agricultural extension leads to agricultural development under conducive social, economic and cultural conditions.

The impact of agricultural extension on a society or on households is felt through its effect in introducing technological changes that normally have their own subsequent consequences. Following Crittenden and Lea (1988), the impact of agricultural extension may be characterized by the following levels: a) Dissemination of knowledge on new technologies through field days, training, advice, etc. which leads to changes in b) input output relationships at farm level using new technologies; c) then the use of new technological input could have market and welfare effects; d) finally agricultural extension may have an important effect on other production related goals and socio-economic developments such as achieving food self sufficiency, creating employment opportunity, improving rural income and its distribution etc.

There are several levels for judging an extension program. These are consequences at societal level or the target group, behavioral change in the target area, farmers' participation in the extension activities and extension agents' opinion about the extension program and activities. Consequences of extension at the higher (societal) level are generally the result of the lower (farmers participation) level (Van den Ban and Hawkins H, 1988, Benneth, 1982). In principle, impact study can be done at all levels. The higher the level the more accurately the evaluator will be able to estimate how far the ultimate goals of an extension program have been reached. At the same time as a rule it becomes more difficult to find suitable measurement criteria for changes at higher level. It is also difficult to prove that the change at the societal level is the result of extension only.

According to Benneth (1988), it is better to evaluate the impact of the project at one of the intermediate levels and goals. He underlined that the target level is the most proper level at which the impact of extension program is most accurately judged with relatively less difficulties. It is because extension is often directed at an intermediate goal, increased farm productivity, in selected target areas (similarly, the target area of SG 2000 is high in potential areas for food crop of which Bako is one).

According to Evenson (1996), the main conceptual theme that are relevant to extension impact is awareness, Knowledge, adoption and productivity sequence. Changes in farmers' behaviour through extension are reflected in quantities of goods produced, in the quantities of inputs used, and in their prices. These, in turn, can be reflected in productivity changes, which are the added value of goods produced from a given set of inputs, made possible by the extension activities (Roger E, 1983 and Neils, 1988). In general, extension service has an impact on each part of the sequence. It can be seen as both substitute for, and complement to, the acquired skill of the farmers.

In this regard, Van den Ban and Hawkins (1988) has set criteria for extension evaluation. Some of them are: extent of farmers' participation in the program, behavioral change in the target group, adoption rate and change in productivity. According to Evenson (1993), studies on extension impacts usually try to measure farmers awareness (and source of awareness), Knowledge, adoption and productivity changes. However, not all studies have examined all parts of the sequence. Most have shown a statistical relationship between the quantity or quality of extension services made available to farmers and increased awareness, knowledge, adoption and productivity. Productivity depends on the adoption of technically efficient practices subjected to the nature of infrastructure and market institution of the community (Breth, 1996).

The literature suggests that it is better to evaluation agricultural extension at one of the lower levels and intermediate goals since extension projects usually have target areas and objectives. Moreover, the cumulative impact of extension on producers' behavioral change is reflected on changes in farm productivity. This is because productivity involves better utilization and timing of inputs and adoption of better practices. Thus, if intensive extension accelerates the diffusion of knowledge related to better crop husbandry, it will cause a larger productivity differential than the traditional practices.

## 3.2 EMPIRICAL STUDIES ON IMPACT OF AGRICULTURAL EXTENSION

Studies on impact of agricultural extension projects on farm households are not many. Most of the available empirical studies are related to the "Green Revolution Technology". The other commonly available literature are the studies made by the World Bank on Evaluation of the Impacts of Training and Visit (T & V) extension system in some developing countries. In Ethiopia, such type of studies are few and are also not to date. So, there is little evidence available on effects of extension systems exercised in the country in general.

Marcelino, et al, (1976) classified the strategies which have been used to deal with the problem of small farmers into different categories, the development of new technologies and production strategies, to increase productivity of the resources used in agriculture. Richard and Larson (1978), also underlined the potential of new technologies for increasing the income of the poor without neglecting the possibility of off-farm jobs. He emphasized the importance of off-farm jobs to generate additional income where the biological technologies and expansion of farm size are fully exploited.

Schultz (1964), in his influential book of "*Transforming Traditional Agriculture*", stated that in traditional agriculture where the maximum potential yield had been achieved, farmers were "poor but efficient". In his study he indicated that the gap between the best practice and the actual practice farmers were doing was actually not very large, and that the potential for yield improvement from extension was low. He effectively pointed out that a rise in maximum potential yields is required to create a potential for extension to be effective. However, evidence from Bindlish and Evenson (1993) and Bindlish, Gbetibou and Evenson (1993) indicate that extension programs in countries with very low technological infrastructure have been effective even when the Maximum potential yields have not been rising.

In agricultural potential areas, diffusion of modern technologies will undoubtedly help to promote agricultural development and raise output levels. However, the extension design and its sound technical approach and strategies determine its success (Neils, 1988). In this line, Sims and Leonard (1990) reported that linear agricultural development and dissemination created problems to small farmers in rural poor areas. The problem was stemmed in part from an over-estimation of the robustness of extension technologies.

The impact of introducing new agricultural technologies depends to a great extent upon the extension strategies and, of course, varies with the country and the region. Estimate of production function for rice after increase in water supply in Ramajerd and Abarj, Iran (Sadaghi 1978) showed different results; upward shift closely to optimum scale of production in Remajered district, but no change was observed in Abarji. Moreover, the impact of Integrated Rural Development Program in Anatapur District, India, improvement achieved by the beneficiaries relative to the non-beneficiaries was estimated to be nearly 10%, that is, only marginal (Eswara et al, 1988). The World Bank (1991) also indicated that Training and Visit (T & V) extension system has had no impact on changing wheat yield after ten years service in Terai of Nepal.

On the other hand, the impact of the T & V extension system, was evaluated in Haryana, India after three years of extension, using the farm level survey data and econometric estimation method (Gershon, et al, 1985). Production and supply functions were fitted. The resulting estimate suggested high yielding varieties of wheat and were about 9% higher than the local cultivar, and there was a gain in productivity (6-7%) for HYV that can be attributed to the extension. Analysis of technological changes and output growth in Harashtra, India, revealed different results for different districts (Patil an Dayanatha 1978). A log-linear regression model showed that only 14 out of 25 districts gained positive total factor productivity growth rate (1.7% per annum), and the output growth rate recorded over 3.5%. But the rest 13 districts showed little progress. It is also confirmed that adoption of new production technologies provide job opportunity. Study on wheat technology in India by Ray et al, (1985) reported that female labour enormously increased on all size of holdings by the adopters.

A recent study by Bindlish and others (1993), found out promising results of T&V extension in Burkina Faso. They evaluated the extension project on the basis of data collected from randomly selected farmers. The study shows that while all farmers have benefited, those that belong to the T&V contact groups have benefited more. That indicates appreciable increase in awareness and adoption has been attained after the introduction of T&V.

For many years, efforts and relatively intensive extension services have been provided to farmers. But, in some cases a clear causal connection between incremental productivity and incremental investment in establishing the extension system could not be identified.

In Ethiopia, several attempts (which is not less than five types of extension approaches) have been made to encourage the adoption of new technologies in order to increase farm productivity in the agricultural sector. However, only few of the programs were able to improve farm productivity due to both external and internal weakness (Tennassie, 1985). Using *Index Number approach* which is based on the theory of consumer and producer surplus, Tennassie identified that CADU/ARDU Research and Extension resulted in different impacts on wheat and barley production in Arsi, Ethiopia.

Yield increases over conventional approach were recorded in SG-2000 project that averaged 217% on maize, 146% on wheat and 200% on sorghum (SG_2000, 1996). But these figures do not indicate whether productivity has really increased since the increase in average yield could be with a proportionate increase in inputs such as fertilizer and labour. Thus, whether farmers using modern inputs (supported by the project) have necessarily changed their production behaviour and basic farm inputs become more efficient than farmers who are using traditional inputs is something that deserves investigation.

On the other hand, Gavian & Gemechu (1996) recently carried out a study on profitability of different wheat production system in Arsi zone, Ethiopia. They compared the profitability of farmers practice and demonstration led by SG-2000. Their analysis indicated that demonstration plots offer yields and profits greater than those most wheat farmers in this region are achieving. However, the result of economic analysis suggested the need for broader testing of the experimental packages on a wider area and other crops taking into account the direct and indirect effects of the technical changes.

In general, the empirical studies indicate that whether different technology extension systems can have different impacts on farm households depend upon the social, economic, institutional and political conditions prevailing in each area. Despite the ultimate goal of extension system (that is, improve farm income), it often happens that there are several consequences that can be positive or negative or both or no effect at all. This implies that there is no general consensus on the effects of agricultural extension systems. Hence, any further study on agricultural extension, particularly in Ethiopia where information is not well developed, will help to develop strategies to promote the economic development of the nation.

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# CHAPTER IV

# RESEARCH METHODOLOGY

## 4.1 DATA SOURCE

Both secondary and primary data were used in this study. The secondary data were collected from different levels of MOA offices, the SG-2000 extension project and the Institute of Agricultural Research. The source of the primary information were the farm households who derive their livelihood mainly from agricultural activities. Much of the information for the evaluation was gathered by interviewing the farmers using a standardized questionnaire. The questionnaire was first pre-tested before it was administered. Enumerators who completed grade 12 and able to speak the local language were recruited and trained for the survey.

Sample selection was based on a stratified two-stage random sampling design. The first stage consists of selecting the extension circle and second selection of extension participant and non-participant farmers within the selected circle. Considering the given time and financial resource constraints, it was necessary to demarcate the area in which the survey should be conducted. Hence, the study was limited to the Bako area, which is one of the major maize producing areas in the country. Based on the number of households in each of the selected Peasant Associations (PA), a simple random sample of six to ten farmers was drawn from each PA. A total of 225 farmers (105 SG-2000 project participant and 115 non-participants) were interviewed. Data on maize output produced and input used, price of product and input were collected. Such information on area of land cultivated, variety type, seed rate, fertilizer level, method of fertilizer application, human and oxen labour used, and information on household characteristics and problems and constraints encountered by the farmers were gathered.

## 4.2 THE MODEL

The model assumes that farmers face the same input-output prices. It proposes that farm productivity varies between farmers using improved technologies and those using the traditional practices. Thus, it was hypothesized that effective use of modern inputs shifts the production function up ward. To measure and compare the marginal products of different farm inputs, microeconomic investigation seem to be appropriate. To evaluate the magnitude of improvement in productivity due to technological changes from the traditional practices, a ***Production Function specification*** is found to be very useful. The basic analytical framework based on the theory of production is illustrated in figure 1.

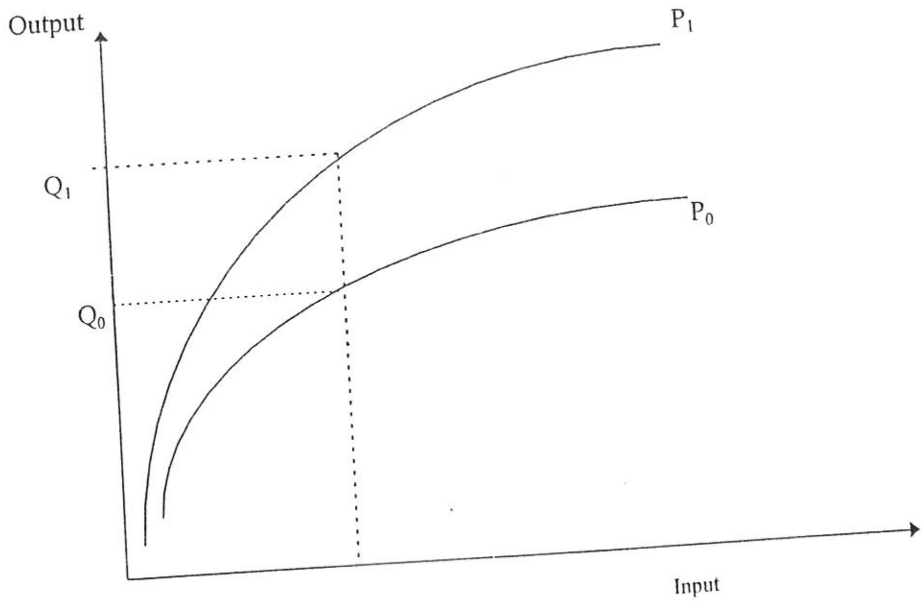


**FIG 1: Shift in production curve from the use of improved technologies**

The shift in the production curve from Po to P1 is induced by increased productivity due to the use of improved technologies. The upward shift in the production curve is essentially an improvement in technical efficiency (an expansion of the frontier). The ex-post evaluation of agricultural extension program geared to increasing the level of productivity was made using the analytical framework.

The typical specification is:

$$Y = F(X_i, Z) \ldots\ldots\ldots (1)$$

Where output, Y, is related to variable input $X_i$ such as labour, fertilizer, oxen hour and seed; and a fixed input Z such as land.

Thus, a Cobb-Douglas production function has been used to estimate the coefficients of the explanatory variables. Despite its wider popularity, the Cobb-Douglas production function has a limitation of (among some others) restriction in elasticity of substitutions. That is, it assumes constant elasticity of substitution (or equal to unity).

The Cobb-Douglas production model commonly employed to evaluate the benefit from such type of program is as follows:

$$Y = A_i \prod_{i=1}^{k} x_i^{\beta i} \exp(\delta I + e_i) \ldots\ldots\ldots (2)$$

Where, the $\beta$ and $\delta$ are the parameters to be estimated, $X_i$ is for inputs as explained above and $I$ is a dummy variable (1 for extension participants and 0 otherwise). For this model $I$ measures the effect of the SG 2000 extension program. And **e** is the random disturbance term, independently distributed with zero mean and finite variance. The proposed model assumes maize physical output mainly depends on the quantity and quality of inputs used in production.

Using the above equation (2) leads to some basic estimation problems. The first source of the estimation problem is the problem of indirect or secondary information flow where knowledge that originates from the extension project is passed on to other farmers who do not directly interact with the project. Information may be diffused instantaneously to other non-participating farmers from participating farmers. In such cases there may be no difference in the performance of participating and non-participating farmers, and an estimate of extension impact based on individual extension contact would be erroneous. It tends to underestimate extension project effects. For this reason, the usual recommended procedure is to analyze technology **adoption** first, and then the adoption levels predicted from this stage are included in the second stage productivity regression (Evenson, 1967; Bindlish, et al, 1993). In this study, however, the case was not the problem. Although there was quite high information diffusion from participants to non-participants as indicated by the level of awareness achieved, almost all the non-participants could not adopt due to the critical problems (discussed in chapter 5). Adopters were found to be the only extension participants. Hence, it is assumed that it is not necessary to include the predicted technology adoption in the subsequent estimation of the productivity differential.

The statistical endogeneity in the extension-farmer interaction is the second problem. It is likely that one of the characteristics of a more productive farmer is the desire to acquire information about changing farm conditions or new technologies. Such a farmer may be inclined to attend more demonstration days, seek out extension contact, etc. Analogously, extension agents themselves may also seek out contacts with better farmers who would be good performers even in the absence of extension contacts. That is, they may be biased in favour of particular types of farmers. In such cases, the extension-contact variable is endogenous, and the estimation of extension's impact on farmer performances are likely to be biased upward, as some of the better performance credited to the superior attributes of the group that interact with extension. As a result, $I$ (in equation 2) is not exogenous in our case as the decision of an individual to participate or not to participate in the program is based on an individual self-selection. Hence, the equation must be estimated using instrumental-variable techniques.

This problem can be handled econometrically using a ***Two-Stage Switching Regression model (models with self-selectivity)*** (Maddala, 1994). Therefore, we have a two-step method of estimating the production function: First, the extension participation decision function was estimated using the *probit model*. This Function (3) enables endogeneous switching in the equation (4) and (5) (Maddala, 1994).

**Extension participation decision function is defined as:**

$$I^{*} = \gamma Zi + \delta \text{ ..........................(3)}$$

The observed $I_i$ is defined as:

$$\mathbf{I_i = 1 \text{ iff } I^{*} > 1 \quad \text{if a farmer participated}}$$

$$\mathbf{I_i = 0 \text{ iff } I^{*} \leq 0 \quad \text{otherwise}}$$

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**$I_i = 1$ iff $I^* > 1$ if a farmer participated**

**$I_i = 0$ iff $I^* \leq 0$ otherwise**

**Zi** = are exogenous variables and γ is a vector of unknown coefficients, and δ is a disturbance coefficient.

The ability and willingness of a farmer to participate in the extension program depends on his/her household characteristics, resource endowment and on the socio-economic environment he/she is faced with. The explanatory variables hypothesized to influence farmers' decision to participate in the SG 2000 extension program are explained below.

- **Dependent variable:**

  $I^*$ = 1 if farm household head participated in the extension, 0 otherwise

- **Explanatory variables:**

HHAGE: The age of the farm household head. Age is a proxy for experience with farming. It affects extension participation, but the direction is not clear.

HHSZ: The household size. It represents the number of potential active family members. Participation in extension demands proper management of farm operations. Thus, higher endowment with labour is expected to participate in extension.

HHEDUC: Education level of the household head. 0 if illiterate, 1 if 1 to 6 years of education, 2 if 7 to 8 years of education and 3 if greater than 8 years of education. Education improves access to information on new ideas and inputs provided by extension workers. Therefore, the more the household head educated the more likely he/she is to participate in the extension activities.

TFRMSZ: Total farm size owned by the household, in hectare. Hosting the extension demonstration requires approximately half a hectare. Thus, farmers with larger landholding are likely to participate in the extension.

NOXEN: Number of oxen owned by the household. The number of oxen owned is hypothesized to be positively related to extension participation.

DSROAD: Distance of the household's residence from the main road, in walking minutes. The closer the household to the main road the more access to extension information would be, and thus positively related to extension participation.

PMRKT: Proximity to the market centre, in walking minutes. Households nearer to market centre are likely to be access to information on new inputs, and thus positively related to extension participation.

GETCRDT: Credit availability for down payment. 1 if farmer has access to credit, 0 otherwise. It is expected to have a positive impact on extension participation.

WORKOFF: Participation in off-farm work. 1 if household head work off-farm, 0 otherwise. The higher the source of income from off-farm works the less likely a household to participate in extension activities

In the second step, the predicted extension participation was included in the estimation of the production functions for the two groups. That is, since the standard normal density function and the corresponding distribution function are a function of Zg, they were estimated and used to construct the *Inverse Mill's Ratio.* The Mill's Ratios were then included in the estimation of the production function to eliminate the influence of the selectivity bias associated with extension participation decision. Hence, a more general model to estimate productivity is as follows:

**For Extension participants:**

$$Y_{1i} = A_{1i} \prod_{1i=1}^{k} X_{1i}^{\beta_{1i}} \exp(\beta_1 Sq + \beta Var + \lambda_1 Mr + e_{1i}) \qquad (4)$$

**For Non-participants:**

$$Y_{2i} = A_{2i} \prod_{2i=1}^{k} X_{2i}^{\beta i} \exp(\beta_2 Sq + \lambda_2 Mr + e_{2i}) .............(5)$$

where Y = Physical output of maize measured in quintal per household (OUTPUT) (1996 data);

and $X_i$:

AREA = Maize area operated by farm households measured in hectare[2];

FERT = Chemical fertilizer (DAP and/or UREA) applied to the crop per farm measured in kilogram;

OXENHR = Oxen hours used per households' maize farm measured in pair bullock-hours;

LBRMD = Human labour per household maize farm measured in man-days[3];

SEED = Maize seed in kg per maize farm;

Sq = Soil quality in terms of its suitability for growing maize as ranked by the farmers (SOILQLT):

(1) poor (2) fair (3) good

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[2] The area of land was converted from the local measurement, oolshaa, to hectare (one hectare is estimated to be five oolshaa).

[3] The conversion factor for manday was adopted from Storck, et al, (1991). Accordingly, age group below 10 was given 0; but between 10 and 13 years 0.20 for both male and female. The correction factor varies for male and female for age group over 13. Between 14 to 16 years, the male was given 0.50 and the female 0.40, while for age group between 17 and 50 the conversion factor for the male was 1.0 and for the female 0.80. Over 50 years, the male was give 0.70 and the female 0.50.

VAR = Improved variety dummy variable, 1= BH-660, 0 otherwise. There was a high demand for the BH-660 by the farmers as it is expected to be superior in productivity to the other improved varieties.

Mr = The Inverse Mill's Ratio, computed from the Extension Participation Function (equation 3).

A, β and λ are parameters to be estimated, and k is the number of regressors.

To evaluate the benefit of the program that has already been created, we need to consider the total gross benefit for all the participants. For each participant with characteristics $g_i$ and $Z_i$, the expected outcome, $Y_{1i}$ in the program and the expected potential outcome without the program, $Y_{2i}$, were compared. The expected gross benefit for the participant i is given by:

$$E(Y_{1i} / I_i = 1) - E(y_{2i} / I_i = 1) = X_i(\beta_1 - \beta_2) + (\delta_{1\varepsilon} - \delta_{2\varepsilon}) \frac{\phi(Z_i\gamma)}{\Phi(Z_i\gamma)} \text{...........(6)}$$

Where F is the standard normal density function and f is the corresponding distribution function. The program will produce greater benefit under self selection if $d_{1e}$-$d_{2e}$ is greater than zero.

*Ordinary Least Square (OLS)* was then applied to estimate the two separated Cobb-Douglas production functions (that is, equation 4 and 5). The **LIMDEP** econometrical package was used to fit the models.

# CHAPTER V

# RESULTS AND DISCUSSION OF THE STUDY

The analyses of the impact of the SG 2000 extension project were made in line with the objectives of the project and/or output of the project. The main objective of the project, as discussed in chapter two, was to achieve increased productivity through the use of improved technologies. Thus, at an abstract level, the expected output of the project is the new farming knowledge acquired, which leads to increases in yield. However knowledge is intangible and in some respects undefinable. It has no well defined market, despite the fact that knowledge obviously has economic value. Because of these difficulties, the researcher attempted to evaluate the project impact in terms of its effect on farmers' awareness of the improved practices of maize production and measurable output effects. As a result, the analyses were focused on effective adoption and productivity changes resulting at farm level.

## 5.1. CHARACTERISTICS OF THE SAMPLE FARM HOUSEHOLDS AND EXTENSION PARTICIPATION

Evaluation of the impact of the SG 2000 project in subsequent chapters is undertaken with reference to certain characteristics of the sample farmers that possibly reflect their economic and social conditions. The selected household characteristics are: (i) household size; (ii) age and education level of household head; (iii) total land owned; (iv) number of oxen owned; and (vi) distance of household residence from the main road or market centre. Evaluations of farmers' participation in extension activities, awareness of the improved practices, adoption of the extension message and its effect on productivity were made with reference to these characteristics.

### 5.1.1 Description of the Sample Household Characteristics

Table 1 and 2 present the descriptive statistics of the household characteristics. Average age of household head of the sample farmers is about 42 with standard of deviation (SD) of 13.50, which is almost the same for both extension participants (SG) and non-participants (NSG). Of the total sample farmers about 95.6% were male-headed and only a little over 4% was female-headed households. This figure of female-headed households is too small to be representative for further analysis. However, it is noteworthy that despite the small number of female households, almost all physically able females participate in agricultural operations in general, and in maize production in particular, in the study area.

The level of formal education in the Bako area appears to be low. Of the total sample 38.3% reported that they had received formal education. Of the 38.3%, more than 90% had attended only a primary level. In this regard, there was no significant difference between the SG and NSG groups. About 66% and 56% of the NSG groups respectively can at least read and write.

The average household size of the total sample farmers was 8.7 persons with SD of 4.14, and ranged from 3 to 28 persons. However, this was different for SG and NSGs. The average family size of the SGs was about 10 persons with SD of 4.5, while that of the NSGs averaged 7.5 with SD of 3.10.

**Table 2: Comparison of SG 2000 Participants and Non-participants**

| Variable | Mean | | T-test for paired samples |
|---|---|---|---|
| | SG | NSG | |
| HHAGE | 42.56 (12.76) | 42.25 (14.8) | 0.20 |
| HHEDUC | 1.04 (4.01) | 0.73 (3.24)_ | 1.26 |
| HHSZ | 10.0 (4.70) | 7.50 (3.10) | 4.61*** |
| TFRMSZ | 3.62 (2.10) | 2.20 (1.41) | 5.53*** |
| DSROAD | 24.44 (24.70) | 36.38 (26.03) | -3.52*** |
| PMRKT | 31.50 (28.40) | 37.34 (33.00) | -3.12*** |
| NOXEN | 3.52 (2.30) | 1.63 (1.63) | 6.61*** |

*** indicates significance level at 1%, and figures in parentheses are the Standard of Deviations.

### 5.1.2 Household Resource Endowment

**a) Farm labour**

Members of a household in the Bako area, similar to any other part of the country, are the largest source of farm labour. Basically, all healthy family members between 12 and 75 years participate in agricultural activities in the Bako area, though their skill and efficiency could actually be different. Thus, household members in this age range were categorized as farm labour. Considering this category, the average farm labour of the SGs was 5.7 person with SD of 3.05 and the farm labour of NSGs was 4.3 with SD of 2.15 persons. Mean of both family size and farm labour of SGs and NSGs are compared and are indicated that they are statistically different at 1% level of significance.

As indicated in Table 3, a lower proportion of sample household (34%) with small farm labour (one to three) participated in the SG 2000 extension program, whereas increasingly higher proportion of households with farm labour over six persons participated in the SG 2000 extension program.

**b) Farm land**

Though land was not abundant in general, it was not so severely short in the Bako area relative to other parts of the country. But, about 42% of the sample household owned 2 or less hectares. The remaining 39% of the sample farmers owned 3 to 4 hectares, and 19% of them owned over 4 hectares. The difference in farm land owned between SG and NSG was large. Mean farm land owned by sample the SG and NSG group was 3.62 and 2.2 hectares respectively.

**Table 3: Farmers' resource endowment by SG 2000 Extension Participation as percent of all Farmers belonging to the indicated categories**

| | Farm Size owned | | | Number of Oxen owned | | | Farm labour owned | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | ≤ 2 n=89 | 2.1_4 n=81 | ≥ 4 n=41 | ≤ 1 n=74 | 2_3 n=70 | ≥ 4 n=71 | 1_3 n=76 | 4_6 n=90 | 7_9 n=35 | ≥ 10 n=15 |
| SG-participate | 35 | 48 | 78 | 18 | 54 | 75 | 34 | 47 | 69 | 80 |
| Non-participate | 65 | 52 | 22 | 82 | 46 | 25 | 66 | 53 | 31 | 20 |
| Total household | 42.2 | 38.4 | 19.4 | 34.4 | 32.5 | 33.1 | 35.2 | 41.7 | 16.2 | 6.9 |

For this study, sample farmers were grouped into three classes based on the size of land they owned. These were: small (less than 2.0 hectares), medium (between 2.10 and 4.0 hectares) and large (over 4.0 hectares). In Table 3, it is shown that the proportion of sample farmers' participating in the extension program increased with their land size. Hence, about 35% of small farmers, 48% of medium sized farmers and 78% of the large farmers were participating in the extension program.

**c) Draft power**

Ox is the only source of draft power in the Bako area. The average number of oxen owned by SGs was 3.5 and that of the NSGs was 1.6 oxen. Unlike farm land, oxen ownership was more constrained in Bako: 34.4% of the sample farmers owned one or no ox though 56.6% of them owned two and above oxen. Similar to farm land, the distribution of oxen between the two groups was also large. The proportion of households participating in the extension program was consistent with that of farm labour and farm size. While only 18% of sample farmers with zero or one ox participated in the extension, increasingly larger proportion of sample farmers with two to three oxen (54%) and over three oxen (75%) participated in the program.

From the analysis of household characteristics, one can notice that substantially more households with larger endowments of farm labour, land and oxen were participated in the SG 2000 extension program. These groups of farm households were clearly economically the better ones.

### 5.1.3 Farmers' Experience with On-Farm Research

In the study area, the Bako Agricultural Research Centre (BARC) is located, and the Department of Agricultural Economics and Agronomy normally undertake experiments on farmers' field. Technology Extension department, also often demonstrates and popularizes improved technologies developed in the BARC and/or else where which are expected to be relevant to the community. Accordingly, farmers were asked whether they had participated in any of research activities carried out by BARC. The result from farmer's response surprisingly indicated that only 4.6% of all sample farmers had participated in the on-farm research. This small number, probably under represent the contribution of BARC to the works of the SG 2000 extension activities. Hence, on-farm research participation was not taken into consideration in further analyses.

### 5.1.4 Farmers Ratings of the Extension Recommendations

Table 4 presents farmers' evaluation of the extension message relating to their characteristics and resource endowments. Actually not all farmers have enough information as to how the SG 2000 extension project was implemented. Hence, the report on farmers rating of the extension recommendations was based on 77% of the total sample farmers who had a good access to the extension project. Of these, 35% rated the SG 2000 recommendations to be highly "applicable"[4] while 41% rated it to be applicable. Thus, the large number of all farmers (76%) who were knowledgeable about SG 2000 rated its recommendations to be applicable. The rest 24% rated the recommendations to be not applicable.

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[4] "applicability" is defined as usefulness, effectiveness having a positive impact on maize production.

Farmers' rating was also viewed based on extension participation, land size and number of oxen they owned. While 97% of the SG group rated it to be applicable, nearly half (47%) of the NSG group rated the recommendations to be not applicable. With respect to farmers' endowment, more farmers who own large farm size (97%), medium farm size (91%) and those with two or more oxen (92%) rated the recommendations to be applicable. On the contrary, a considerable number of farmers with smaller farm size (31%) and with one or no ox (68%) rated the extension recommendations not as applicable. Therefore, the ratings suggest that greater contact and participation of farmers in the extension program could increase farmers knowledge of the content of the program and appropriate application of the extension recommendations. The direct and positive correspondence of farm size and number of oxen owned with the ratings also imply that those farmers find the extension useful because they possibly have better access to inputs and capital and can, therefore, implement the recommendations properly.

**Table 4: Farmers' Ratings of the SG 2000 Extension Recommendation (in percent)**

| Rating | All Farmers N=185 | SG 2000 participants | | Farm size | | | Oxen number | |
|---|---|---|---|---|---|---|---|---|
| | | SG N=100 | NSG N=85 | Low N=68 | Medium N=62 | Large N=31 | ≤ 1 N=56 | ≥ 2 N=107 |
| Highly applicable | 35 | 45 | 22 | 11 | 43 | 67 | 5 | 45 |
| Applicable | 41 | 52 | 31 | 57 | 48 | 30 | 29 | 47 |
| Not Applicable | 24 | 3 | 47 | 31 | 9 | 3 | 62 | 8 |

Among reasons mentioned for rating as not applicable were absence of complementary technologies in post harvest management, and lack of market incentives. Most of the low resource endowed farmers rated the project approach and recommendation to be not applicable.

This might be due to shortage of capital assets (especially land and oxen) and financial means without which they could not easily use the improved practices

## 5.2 AWARENESS, ADOPTION, PRODUCTIVITY AND PROFITABILITY OF THE IMPROVED MAIZE TECHNOLOGIES: EMPIRICAL RESULTS

### 5.2.1 A Descriptive Analysis of Farmers' Awareness and Adoption of the Improved Maize Technological Packages

The analyses of farmers' awareness and adoption of the extension messages were undertaken in the context of four important practices: (i) improved seed, (ii) seed rate, (iii) fertiliser rate, and (iv) fertiliser application method.

#### a) Farmers' awareness of the improved maize technologies

There was a high degree of awareness of improved practices among the sample farmers. As represented in Table 5, over 65% of all sample farmers were aware of the recommended practices. Appreciably, about 94% of them were knowledgeable of the improved seeds and about 87% were aware of the improved method of fertilizer application.

Although the proportion of the educated household heads (who were aware of the practice) was slightly higher in each practice, there was no significant difference suggesting literacy as an important factor for technology awareness. On the other hand, the proportion of the SG group was quite higher than the NSG in every practice.

Almost all SG sample farmers were aware of all of the recommended practices except for seed spacing. In fact, significant numbers of NSG were also aware of improved seed (87.5%), improved method of fertiliser application (75.8%), recommended seed rate (41%) and recommended fertiliser rate (43.6%). Thus, though the dimension of awareness over time was not estimated, the analysis indicates that the SG 2000 extension approach had a very strong information diffusion effect.

**Table 5: Awareness of the Recommended Improved Maize Production Practice by SG 2000 Extension Participation and Household head Education Level**

| Recommended Practices | Percent of Respondents | | | | Percent of all sample farmers |
|---|---|---|---|---|---|
| | SG N=104 | NSG N=110 | House hold head Education | | |
| | | | Yes (N=132) | NO (N=82) | |
| Improved Seed | 100.0 | 87.5 | 95.6 | 92.2 | 93.5 |
| Seed rate | 91.3 | 40.9 | 67.2 | 64.3 | 65.4 |
| Fertilizer rate | 88.5 | 43.6 | 68.4 | 62.8 | 65.0 |
| Fertilizer application | 99.0 | 75.8 | 86.6 | 87.4 | 87.1 |
| Seed treatment | 93.3 | 26.6 | 61.0 | 26.5 | 59.4 |

**b) Adoption of the improved maize technologies**

A much higher proportion of the SG group adopted the improved maize production practices than is the case for the NSG group. Nearly all sample SG farmers adopted improved seed (96%), recommended seed rate (89%), recommended fertiliser rate (87%) and fertiliser application (97%). But a relatively much lower proportion of the NSG group adopted these components. Only 9.1% of the NSG group adopted the improved seed, 8.2% the recommended seed rate, 9.1%

the recommended fertiliser rate and about 10% of the NSG group adopted the improved fertiliser application method. All sample farmers rejected seed treatment with chemical "marshall" that was meant for soil born diseases. Indeed, information from farmers and extension agents indicates that soil born disease is not a common problem in the area.

Considering the four top recommended and transferred practices (improved seed, seed rate, fertiliser rate and fertiliser application method), the proportion of adopters for the SG and NSG sample farmers was quite different and cannot be compared. While almost all of the SG sample adopted these practices, only about 10% of the NSG sample adopted them. Hence, it can be concluded that the adopting sample farmers were almost only the SGs. Because the number of the NSG who adopted the improved maize technologies is too small to consider, the adopting NSG households were excluded from further analysis.

The average total maize area cultivated by the SG sample was 1.43 with a SD of 1.06 hectares, and that of the NSG sample was an average of 0.84 with a SD of 1.06 hectares. The mean difference is highly significant at the 1% level (t-ratio equals 3.5). The SG sample farmers covered an average of 62.3% of their total maize area cultivated with the improved practices, but the NSG covered only 24%. Thus, the area under improved maize production was generally small relative to the total farm land the farmers allocated for maize production. Those farmers who adopted the improved practices, were also using the traditional maize production system. They mentioned several reasons of which the major ones were: i) problem of storage pest (100%); ii) averse market risk (76.2%); iii) shortage of improved seeds (57.1%); iv) cash constraint to purchase improved seeds and fertiliser (44.8%); v) risk aversion that may be associated with the new practices (33.3%); and vi) farmers simply (may be due to taste and features) wanted to keep their local varieties (27%).

**Table 6: Proportion of Farmers Adopting Recommended Practices of Maize Production by Extension Participation, 1997 (%)**

| Recommended Practices | Extension Participation | |
|---|---|---|
| | SG (N=104) | NSG (N=110) |
| Improved seed | 96.2 | 9.1 |
| Seed Rate | 89.4 | 8.2 |
| Fertilizer rate | 87.5 | 9.1 |
| Fertilizer application | 97.1 | 10.1 |
| Seed treatment | 4.8 | 0 |

### 5.2.2 Constraints and Problems on the Adoption of the Improved Maize Technologies

The decision to adopt any improved agricultural input is determined by a number of factors. Regarding maize technologies under consideration, the improved inputs were found to be more productive than the traditional practices as shown in chapter five. However, a good number of farmers had not adopted some or all practices. Table 7 summarized reasons for not adopting the improved maize production practices. Those farmers who had not adopted the extension recommendations identified the primary reasons preventing them from doing so. Inadequate knowledge of the practices; costliness of the practices; lack of insufficient resources (specially land and oxen); unavailability of the inputs; financial constraints; labour shortage; profitability (from farmers' point of view); and risk avoidance behaviour of the farmers were the main constraints that farmers identified.

The first four serious problems identified by those farmers who had not adopted the improved maize seed were unavailability of the seed (48%); too expensiveness (38.0%); lack of sufficient land and/or oxen (32.3%); and fear of risk associated with market price fluctuation (28.4%). Very few sample farmers indicate that lack of awareness, financial constraints, and labour shortage as reasons preventing them from adopting the improved seed.

The other practice complementary to the use of improved seed was seed rate. Many sample farmers (51.1%), explained their decision not to adopt the recommended seed rate due to insufficient knowledge of the practice. As a result, almost all sample farmers who did not adopt the improved seed also did not apply the recommended seed rate. The second highest proportion of non-adopting sample farmers (37.6%) did not adopt the technology for reasons related to the risk avoiding behaviour of farmers: they wanted to avoid risks that possibly arise from animal or wild life damage and moisture stress. Because the recommended seed rate was more sparse than the traditional practice, the sample farmers believe that loss of a maize plant by any reason is loss of much product. Few sample farmers (15.4%) considered the recommended seed rate to be not profitable.

Notably, the largest proportion of the sample farmers (55.6%) who had not adopted the recommended fertilizer rate was constrained by lack of financial resources. More than 38% of the sample non-adopters felt that the recommended fertilizer rate was too expensive to buy and apply. The third critical problem identified by 36.2% of non-adopters was the risk associated with output price fluctuations (Fig. 2). Indeed, a good proportion of them are not aware of the recommended rate (34.7%), while another 31% think that it is risky to practice. Not surprisingly, some of them (16.4%) felt that the recommendation was not profitable. Only a small proportion of the non-adopters cited the unavailability of fertilizer and constraint of land/or oxen as important reasons for not adopting recommended fertilizer rate.

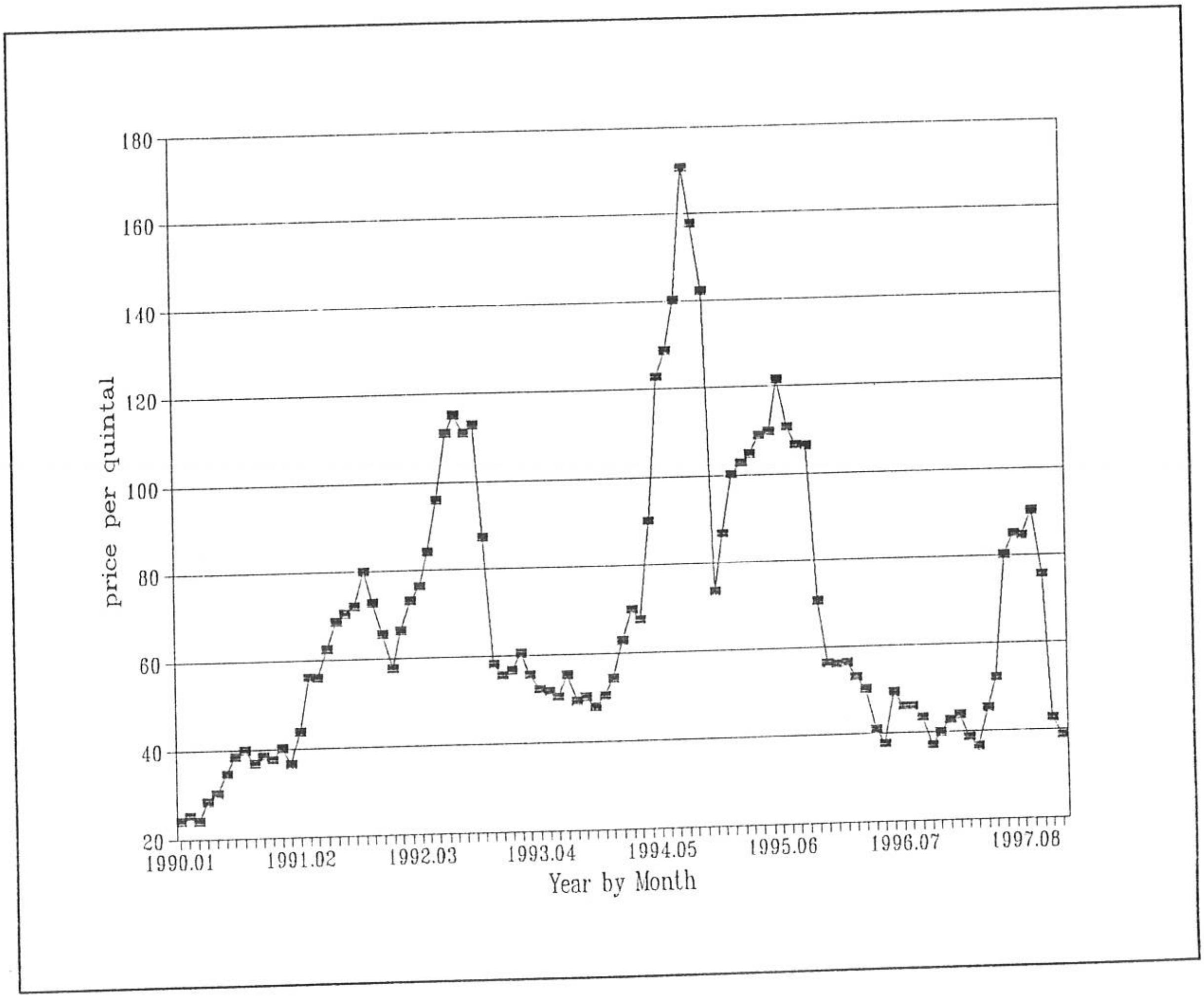


**Fig 2: Maize Price 1990 to 1997, Bako Area**

Source: Department of Agricultural Economics, Bako Agricultural Research Center

A large number of the non-adopters of the recommended fertiliser application method (i.e spot application) (54%) attributed their decision to lack of sufficient labour. The problem of labour was likely to be associated with farmers' inability to hire labour in order to supplement family labour. Lack of adequate knowledge and risk avoidance were reasons for 25% and 24.5% of the non-adopting sample farmers respectively. Farmers felt that such type of fertilizer application is risky in case soil moisture is not adequate at the time of seed germination.

The only extension recommendation that was entirely rejected by all farmers was the "marshall" chemical application. It was basically meant to prevent or control soil born diseases that could damage the maize plants. Over 87% of the sampled farmers reported that the chemical was not profitable (in the sense that it was not applicable) to the area at least in the current condition. They explained that they did not have the problem of soil born diseases. On the other hand, termites were considered to be very important problem. In fact, a large number of sampled farmers (42%) had not known the chemical, and quite a high proportion of them also felt that the chemical was too expensive (48%) and 35% reported that the chemical was not available in the market.

**Table 7: Reasons for Non-adoption of the Improved Maize Technologies and the proportion of respondents (amongst farmers not adopting but needing the practice)**

| Reasons for non-adoption | Improved seed | Seed rate | Fertilizer Rate | Fertilizer application | Marshall chemical |
|---|---|---|---|---|---|
| Not aware | 12.5 | 51.1 | 34.7 | 25.0 | 42 |
| Too expensive | 38.0 | 0.0 | 38.7 | 0.0 | 48 |
| Not available | 48.1 | 0.0 | 11.3 | 9.7 | 35 |
| Land/oxen constraint | 32.3 | 0.0 | 12.2 | 0.0 | na |
| Market Risk | 28.4 | na | 36.2 | na | na |
| Cash shortage | 15.0 | 0.0 | 55.6 | 0.0 | na |
| Labour shortage | 7.7 | 0.0 | 0.0 | 54.0 | na |
| Risk avoidance** | 7.6 | 37.6 | 31.0 | 24.5 | 5.7 |
| Not profitable | 0.0 | 15.4 | 16.4 | 0.0 | 87 |

na = Information was not available
** = Risks associated to insect pests, animal damage and weather calamities.

In general, many farmers may be aware of the extension recommendations, but lack the detailed knowledge about the contents and correct application of the technologies. This points to the need for extension to work more closely with farmer. Financial constraint that directly arises from farmers' poor resource base, and consequently, the costliness of the recommended inputs and their inability to hire labour could be considered to be the main impediment to adopt the improved maize production practices. It is noteworthy that almost all of the non-adopters complained about the unavailability of the improved seed in the required amount and time, without which it is unlikely or even may not be useful to adopt the other recommended improved practices. This is because all the other recommended practices are complementary to the improved seed. The improved seed is rationed only for the extension participants.

### 5.2.3 Econometric Analysis on the Determinants of Extension Participation

The idea of the factors affecting farmers' extension participation is useful since the groups are the main vehicles through which extension influences decision in the agricultural sector. Farmer's participation in extension program is affected by the supply of extension services in general. The farmer, however, has a demand for participation that is governed by factors related to his/her household characteristics and socio-economic circumstances. The variables hypothesized to affect farmers' decision to participate in the SG 2000 extension program were selected to fit the Probit Model.

In a cross-sectional data, socio-economic variables usually have the problem of multicollinearity. This would result in unexpected relationship between the explanatory variables and the dependent variable. Hence, to make the estimates more reliable, all the variables hypothesized to influence farmer's decision to participate in the extension were first taken together and were checked for multicollinearity. A bivariate correlation matrix was computed to test for high collinearity. Then variables which showed highly significant collinearity were excluded from the model. Accordingly, PMRKT and WORKOFF were highly associated with each other and to DSROAD. WORKOFF was also strongly and negatively correlated with NOXEN and TFRMSZ. Hence, PMKT and WORKOFF were dropped from the analysis. Finally, seven variables namely DSROAD, HHSZ, NOXEN, HHAGE, TFRMSZ, HHEDUC and GETCRDT were used in the probit model. The Maximum Likelihood Estimates of the probit model is presented in Table 8.

The partial derivatives (marginal effects) of the variables on the probability of farmers' participation decision are also shown in the third column of the Table 8. The marginal effects of the vector characteristics are computed at the means of the variables for all observations. As indicated in the table, all variables have the expected signs. Out of the seven variables entered into the analysis, only two variables were found to be not significantly influencing farmers' decision to participate in the extension program. DSROAD has a negative sign implying the farther the household residence is from the main road, the more he/she tends not to participate in the extension program. Farmers who live far from the main road could be less accessible to extension services and do not have information on improved farm technologies, and hence are more unlikely to participate in the extension program. The influence of the HHAGE on extension participation is not statically significant at 10% level.

NOXEN and TFRMSZ have positive signs and significantly (at 1% and 5% level, respectively) affect the farmers' decision to participate. This supports the notion that oxen and farm land are among the most important and basic farm inputs (assets) without which farmers may not be able to operate their farm activities smoothly. The two variables may also proxy the wealth status of a household. They can be source of cash and security against risks of crop failure. This result is consistent with the result of Donal, et al (1977) that indicated wealthy farmers are relatively less influence farmer's decision to participate in the extension were first taken together and were checked for multicollinearity. A bivariate correlation matrix was computed to test for high collinearity. Then variables which showed highly significant collinearity were excluded from the model. Accordingly, PMRKT and WORKOFF were highly associated with each other and to DSROAD. WORKOFF was also strongly and negatively correlated with NOXEN and TFRMSZ. Hence, PMKT and WORKOFF were dropped from the analysis. Finally, seven variables namely DSROAD, HHSZ, NOXEN, HHAGE, TFRMSZ, HHEDUC and GETCRDT were used in the probit model. The Maximum Likelihood Estimates of the probit model is presented in Table 8.

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**Table 8: Probit Maximum Likelihood Estimation (MLE) of the Extension Participation**

| Explanatory Variables | Coefficients | Partial Derivatives | Means of the Variables |
|---|---|---|---|
| CONSTANT | -2.036 (2.48)** | -0.811 | |
| DSROAD | -0.416 (4.29)*** | -0.166 | 2.94 |
| HHSZ | 0.0498 (1.51) | 0.020 | 8.79 |
| NOXEN | 0.234 (3.17)*** | 0.093 | 2.55 |
| HHAGE | -0.010 (0.91) | -0.004 | 41.50 |
| TFRMSZ | 0.033 (1.95)** | 0.013 | 2.89 |
| HHEDU | 0.377 (2.44)** | 0.150 | 0.88 |
| GETCRDT | 1.878 (2.91)*** | 0.748 | 0.93 |

Chi-squared (7) = 91
Log Likelihood = -95
Restricted Log Likelihood = -141
PSEUDO - $R^2$ = 0.33
COUNT - $R^2$ = 0.78
Sample Size = 204

Figures in the parenthesis are t-ratios.
***, ** and * indicate significance levels at 1, 5 and 10%, respectively.

HHEDUC and HHSZ have also positive sign as expected. HHEDUC is statistically significant at 5% level. And a change of farmer's schooling from the lower to the next higher level has a marginal effect of about 15% on his/her probability to participate in the extension program. Less important but still large is the role of the HHSZ (taken as proxy for labour availability) which has a marginal effect of only 2%. But increase in household size from two to ten would increase the probability of individual farmer to participate in extension program by 15%.

GETCRDT was positively related to the farmers' decision to participate in the extension, and is highly significant at 1% level. The marginal analysis also showed that other factors held at their mean level, credit availability for down payment alone affected farmer's probability to participate by about 75%. Therefore, it suggests that access to credit was the most important factor determining farmers' probability to participate. Credit enables farmers to buy costly inputs such as fertilizer and thereby promote the adoption of the improved practices.

**Table 9: Frequencies of Actual and Predicted Outcomes of Extension Participation**

| Actual | | Predicted | | |
|---|---|---|---|---|
| | | 0 | 1 | Total |
| | 0 | 92 | 26 | 108 |
| | 1 | 19 | 77 | 96 |
| | Total | 101 | 103 | 204 |

The result showed that larger farmers (in terms of both farm area and number of oxen owned), households with larger family size were more likely to participate in the extension activities.

However, GETCRDT, DSROAD and HHEDUC have the strongest effects on farmers' decision to participate in the extension which attracts policy attention.

Table 9 reports the maximum probability of predicted outcomes. The probit model correctly predicted that only 26 (24%) farmers out of those farmers who are not currently participating will have a maximum probability to participate in the extension. As indicated earlier, adopters were just the extension participants. Thus, the predicted frequencies of the extension participants imply that a few of the non-participants might adopt the technologies.

### 5.2.4. Estimation of the Productivity Differentials in the Production of Maize

Table 10 shows the means and the SD of the variables of SG and NSG for the sampled households used in this study. The table illustrates that the SG and NSG households use different levels of inputs and produce widely different outputs. Especially, the level of fertilizer used per hectare by the SGs was more than four times than that of the NSG on the average. While the SGs applied DAP (33%) and UREA (66%) in combination, the NSGs applied only DAP. Comparing human and oxen labour used per area cultivated for maize, the SGs used more than the NSGs. The output produce per hectare by the SGs was more than two times that of the NSGs on the average. However, the SD of the variables were not markedly different between the two groups.

The estimated parameters of the production function for the SGs and NSGs are presented in Table 11. Major input variables and the predicted "extension participation (Mills ratio)" in the probit model above were included as a candidate variable.

**Table 10: Means and Standard of Deviation of the Variables Used in the Production Function by Extension Participation**

| Variables | SG | | NSG | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| OUTPUT | 32.67 (49.50) | 2.61 | 15.60 (18.60) | 13.05 |
| SEED | 16.55 (25.10) | 2.40 | 26.40 (31.43) | 3.81 |
| LAND | 0.66 | 0.87 | 0.84 | 1.02 |
| FERT | 184.00 (278.80) | 1.22 | 54.07 (64.37) | 1.70 |
| LBRMD | 94.84 (143.70) | 5.20 | 80.60 (95.95) | 4.65 |
| OXENHR | 89.00 (134.84) | 4.40 | 96.75 (115.20) | 8.12 |

Figures in parentheses are means of the variables per hectare.

Although elasticities of production estimated by the Cobb-Douglas model fitted to farm level data sometimes gives unexpected results (Roy Chwdhury, et al 1975), the results of this study is quite satisfactory. The result of the production function shows that there are significant differences in input utilization between the SGs and NSGs as seen from the coefficients of the variables in column 2 and 3 of Table 11. The difference in the output elasticity coefficients of the two groups tells us the productivity differential.

All the parameters estimated are significant at the indicated levels by the asterisks for the SGs, while four out of the seven variables are significant for the NSGs. In both groups, all explanatory variables have the expected sign.

**Table 11: Two-Stage Switching Regression Estimates of a Cobb-Douglas Production Function**

| Variables | Coefficients | |
|---|---|---|
| | SG (N=96) | NSG (N=98) |
| CONSTANT | 0.348 (1.13) | 0.264 (1.23) |
| SEED | 0.070 (1.47) | 0.061 (1.99)** |
| LAND | 0.241 (1.76)* | 0.347 (2.14)** |
| FERT | 0.199 (1.89)* | 0.075 (1.95)* |
| LBRMD | 0.237 (2.36)** | 0.174 (1.28) |
| OXENHR | 0.144 (1.68)* | 0.201 (1.66)* |
| VAR | 0.069 (2.68)*** | ___ |
| SOILQLT | 0.033 (2.95)*** | 0.021 (1.52) |
| Mr | 0.081 (1.78)* | -0.0065 (0.23) |
| Adjusted $R^2$ | 0.64 | 0.72 |
| F Ratio | 22.41 | 37.23 |
| Wald test ($X^2$) | 22.30 | 12.60 |

Figures in the parenthesis indicate t-ratios in the absolute value.

***, ** and * indicate significance level at the 1%, 5% and 10% respectively. Both the dependent and the explanatory variables are in their logarithm form.

LBRMD and SOILQLT were not statistically significant for the NSGs. It implies that the improved practice of maize production is more responsive than the traditional practice of maize production (as indicated by their coefficients) to labour and to favourable soil quality for growing maize. The Dummy variable (VAR) is used in the production function estimate of the adopters to capture the productivity differences in the different HYV. It is highly significant at 1% level. Therefore, the analysis confirmed that variety "BH-660" is superior in productivity to the other improved maize varieties used in the study area. Hence, the higher demand for this variety by SGs is consistent with the result. The coefficient of VAR indicates that all other variables held constant, a farmers who used the BH_660 would obtain on average about 7% higher output than a farmer who used the other improved varieties. Moreover, the BH-660 is the most preferred variety for taste. Thus, this information may help the extensionists and other concerned bodies to give due consideration in diffusing improved seeds to the farming communities.

Overall, AREA, LBRMD and OXENHR have larger output elasticities than the other input variables. The magnitude of the individual output elasticities are, however, different. The coefficients of FERT and LBRMD are larger for the SGs than for the NSG. For instance, other factors held constant, a 100% increase in fertilizer use would raise output by 20% for the SG, but only by 8% for the NSG. Similarly, a 100% increase in labour use would result in output increase by about 24% for the SGs, but only by 17% for the NSG. Moreover, the coefficients of FERT and LBRMD for the SG are significantly greater than they are in the NSG at 10% level. Hence, the result suggests that output is more responsive to fertilizer and labour under the improved practices than is under the traditional practices of maize production in the study area. In turn, the output elasticity coefficients of AREA and OXENHR are greater for NSGs than are for the SGs. Thus, the result is consistent with the notion that higher output is obtained by increasing more of the area under cultivation and higher oxen labour (which demands larger number of oxen) under the traditional practices than is under the improved practices. The other coefficients of the variables can be similarly explained. From the elasticity coefficients, one can conclude that the improved practices imply more of intensification (increase use of fertilizer and labour) while the adopters to capture the productivity differences in the different HYV. It is highly significant at 1% level. Therefore, the analysis confirmed that variety "BH-660" is superior in productivity to the other improved maize varieties used in the study area. Hence, the higher demand for this variety by SGs is consistent with the result. The coefficient of VAR indicates that all other variables held constant, a farmers who used the BH_660 would obtain on average about 7% higher output than a farmer who used the other improved varieties. Moreover, the BH-660 is the most preferred variety for taste. Thus, this information may help the extensionists and other concerned bodies to give due consideration in diffusing improved seeds to the farming communities.

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The sum of the output elasticities is 0.89 for the SGs and 0.83 for the NSGs, indicating constant return to scale (chi-square equals 22 for the SGs and 12 for NSGs, both significant at 10% level). The higher sum of output elasticity for the SGs than for the NSG implies that adopters using the improved technologies of maize have slightly raised the optimal scale of maize production to the higher level of output. They adjusted the new optimal level by allocating more amount of fertilizer and labour to this crop.

The Mills ratio (selectivity) variable which measures the non-linear effect of selectivity of farmers is significant at 10% level for the SGs. It shows that farmers who used the improved practices of maize production have larger farm productivity than the average farmers. Therefore, the program of technology transfer produced greater benefit under self selection of the farmers than would it be by random selection of a farmer to do so. Moreover, the result of the Mills ratio confirmed that the use of the technologies by a farmer is endogenously determined that depends on his/her household and socio-economic behaviour.

### 5.2.5 The marginal product of the inputs and Profitability of the Production of Maize

The marginal product of the inputs used in the production function can be calculated from the elasticity coefficients shown in the Table 11. At the actual mean level of the output produced and the average input level used in the production process, the marginal product of the inputs were computed from the estimated elasticities. The results are presented in Table 12.

The marginal products of all inputs for the SGs are much greater than that of the inputs for the NSGs. The difference is astonishing for some of the inputs like seed, labour and land. The marginal product of the seed for the SGs is about four times higher than it is for the NSGs. So, it indicates that the productivity of the improved seeds are much superior to the local seeds. The marginal products of labour and land are about two times higher than they are for the NSGs. Other inputs for the SGs also have moderately higher marginal product than are for the NSGs. In general, the results indicate that farmers using the improved practices in maize production dramatically raised the productivity of all of their farm inputs.

Further more, the gross benefit (in terms of physical quantities of grain maize in quintals) obtained from the use of the improved practices of maize production over the potential output of the traditional practice can be calculated using equation (6). The gross benefit is, therefore, the excess of the amount of the expected value of estimated output produced by the SGs over the expected value of the output produced by the NSGs. The expected values of the outputs were computed by the computer in the LIMDP package. Accordingly, the expected value of the output produced by the SGs was found to be 61.70 quintals per hectare and that of the NSGs was 24.45 quintal per hectare. Thus, the gross benefit from the use of the improved practices of maize production was estimated to be 37.25 (61.70-24.45) quintal per hectare. In other words, the 37.25 quintals of grain maize also indicates the increment in yield or productivity. Therefore, the result confirmed that the gap between the potential yield possible with improved maize technologies and the potential yield level attained by the farmers using traditional practice is very wide.

Besides the information they give on productivity, the improvement in output elasticities of some of the inputs and rise in the marginal products also tell us that the use of the improved maize technologies is more profitable than the traditional practices. However, the analyses would be more robust if the success of the extension program is evaluated from the cost-benefit point of view. Although all costs and benefits in agricultural practices cannot be fully considered and incorporated into the analysis, a simple accounting of financial costs and benefits can be done[5]. In this case, it is assumed that both types of farmers generally face the same input and output prices.

**Table 12: Marginal Products of the Inputs Used in Production of Maize by Extension participation**

| Inputs | SG | NSG |
|---|---|---|
| SEED | 0.1381 | 0.0372 |
| LAND | 11.930 | 6.440 |
| FERT | 0.0353 | 0.0216 |
| LBRMD | 0.0816 | 0.0337 |
| OXENHR | 0.0529 | 0.0395 |

Three scenarios were considered in calculating the net benefits for the SGs because of the need to consider the opportunity cost of capital used for extra purchase inputs (in terms of interest rate)

[5] The expected estimated output, and the average inputs presented in Table 10 are used in this analysis. Grain maize was valued at average market price of 45.35 Birr per quintal, i.e the 1996 price data. As over 90% of the sample SGs used the hybrid seeds, prices of these seeds in the year 1996 (i.e 5.25 per kilogram) was used. For the local seed, average price of maize in planting season (0.60 Birr per kilogram) was taken. Prices for DAP and UREA in the 1996 2.00 and 1.90 birr per kiligram respectively. Human and oxen labour were valued at their opportunity costs. For human labour, the local wage rate (3.00 Birr per day) plus lunch expense (2.00 Birr per day per person) which is equivalent to 5.00 Birr per day was used. Local average renting price of a pair of oxen estimated to be 1.00 Birr per hour was applied.

that it could have earned in the best alternative. The extra amount of cost used for purchased inputs, fertilizer and seed, in the improved practices is 541.02 (669.28-128.26) birr per hectare. The CIMMYT (1988) methodology suggests that the new technologies must offer a minimum rate of return from 50% to 100% depending on the extent to which farmers are familiar with the technologies. From Table 13, it can be noticed that the net benefit for the SGs from the improved practices of maize production is substantially higher than that of the NSGs in the three scenarios.

Without considering the opportunity cost of extra cost of the purchased inputs the net benefit for the SG are over three times higher than that of the NSG and the MRR is 213%. The MRR 213% suggests that for every one Birr invested in the improved practices farmers can expect to recover the one Birr, and obtain an additional 2.13 Birr. The other MRR can be similarly interpreted.

Applying the interest rate of 50% to the difference in costs for fertilizer and seed, the total cost of the improved practices rises to 1793.13. Hence, the net benefit of the improved practices drops to **996.97** Birr per hectare and the MRR falls to 91%. In this scenario the net benefit for the SG is over two and half times higher than that of the NSG using the traditional practices. Using the maximum interest rate (100%), the total cost of the improved practices rises to 2063.64 Birr per hectare, and the net benefit further falls to **726.46** Birr per hectare and the MRR to 36%. Still the net benefit for the SG is about two times higher than that of the NSG. Thus, under in the all scenarios of the interest rates, use of the improved practices is more profitable than the traditional practices. From Table 13, the value of the incremental yield of the crop to total cost (VCR) of fertilizer and seed per hectare are found to be 3.13 and 12.76 respectively. It follows that the SGs have benefited substantially from the use of the improved maize technologies. At present, use of the improved technologies is affordable at least by some farmers and is performing well above the traditional ones. This must arise from the differences in the household characteristics and resource endowment of the farmers as seen in the probit analysis.

**Table 13: Costs and Benefits of Maize Production by Extension Participation (Birr per hectare), 1996**

| Description | SG | NSG |
|---|---|---|
| **1. Gross Revenue** | **2790.10** | **1108.81** |
| **2. Total Costs** | **1522.62[1]** | **723.21** |
| | **1793.13[2]** | |
| | **2063.64[3]** | |
| Purchased Inputs: | | |
| Seed | 131.78 | 18.86 |
| Fertilizer | 537.50 | 109.40 |
| Sub-total | 669.28 | 128.26 |
| Human Labour | 718.50 | 479.75 |
| Oxen labour | 134.84 | 115.20 |
| **3.1 Net Benefit[1]** | **1267.48 (213%)** | **385.60** |
| **3.2 Net Benefit[2]** | **996.27 (91%)** | ___ |
| **3.3 Net Benefit[3]** | **726.46 (36%)** | ___ |

[1] Calculated without considering the cost of capital on the additional cost of the purchased inputs. [2] and [3] are calculated considering the cost of capital for the additional cost of the purchased inputs at the 50% and 100% interest rate respectively.

Figures in the parentheses are the Marginal Rate of Returns (MRR)[6] per hectare.

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[6] $$MRR = \frac{\text{Net Benefit for the SG - Net Benefit for the NSG}}{\text{Total Cost of SG - Total Cost of NSG}} * 100$$

## 5.3 TECHNICAL AND POLICY PROBLEMS AFFECTING THE SUSTAINABILITY OF THE IMPROVED MAIZE PRODUCTION SYSTEM

The concept of sustainability is narrowly used here, as keeping an effort going continuously or the ability to last out and keeping from falling. Therefore, the definition would suggest that the improved productivity level would be sustainable if the use of the improved maize technologies could be maintained over time. From the analyses it has been shown that important number of farm households have adopted the improved maize production practices, and some more are also predicted to adopt. The use of the improved practices of maize production was found to be more productive and profitable than the traditional practice indicating that it is economically viable. However, improvement in productivity or economic viability alone is not by itself adequate to fully endorse the sustainability of the use of the improved maize production.

Therefore, the question is whether adopters and potential adopters consistently use the improved practices and maintain the productivity level gained. Availability of complementary inputs; consistency in input supply in a required quantity and quality (mainly the improved seeds) in time and space; and stability of output and input market price; and adequacy in credit facility are the major determinants of the sustainable use of the improved maize technologies. In this regard, some basic problems and constraints that farmers (adopter and non-adopters) are currently faced with are discussed below.

### 1. Post-harvest loss

While focusing on the need for higher level of food production, it is recognized that post harvest losses (by rodent and insect pests) seriously impact the level of grain available to the consumers as reported by all sampled SGs and 23% of the NSGs. The SGs complained that the improved seeds are more sensitive to storage pest damage than the local seeds. But complementary technologies for post-harvest management that may give remedy to the problem of storage pests are nearly absent. Such loss may inhibit the sustainable use of the improved seeds and then the improved maize technologies in general.

**2. Deterioration of genetic purity**

About 53% of the sampled SGs and some interviewed extension agents reported that even with high input, yield of the improved varieties of maize could not be consistently maintained. During the field survey, it was also observed that in some farms improved maize plants were lacking uniformity in their stand and flower colour. Breeders say that such symptoms are reflection of losses in genetic purity of the varieties. And this could occur due to lack of proper control in seed multiplication centre and/or in seed processing and distribution activities or it could be genetically inherited. Therefore, it implies that in the long run the improved seeds may not be better than the local seeds. Thus, unless substitute improved seeds are developed use of only the current ones may not last long.

**3. Lack of market incentive**

An inevitable consequence of technological change is the increase is the risk of market price changes. Technology pushes forward productivity gains, forcing down ward real producers' prices. Though empirical evidence has not been presented as to how much use of maize technology affected maize price, information from farmers interviewed tells us that at least its effect on the locality under study is not small. This indicates that there was relatively excess product available in the area. Maize price is also seasonally sharply fluctuating (Fig.2). Evidence from 83% of the sampled adopters and over 24% of the non-adopters indicated that farmers have been confronted with the problem of low and fluctuating market price of the maize product.

Farmers can get only limited market information. Even if they get market information, their chance to use the opportunity is very low. The first problem as reported by 87% of the sampled farmers is absence of good storage facilities to keep their produce till the price rises; and the second problem is lack of adequate transport, 54% of sampled farmers reported. The other problem that all sampled farmers are complaining about is high expenditure (mainly for tax and loan payments) from January to March in which agricultural products generally receive the lowest price. Consequently, over 73% of the sample farmers are forced to sell much of their maize product immediately after harvest and so fetch low price.

On top of seasonal price variability, the output price fluctuation is largely governed by weather changes as farming is predominantly under rainfed condition. For instance, maize price reached its pick in August 1994 (175 Birr per quintal) and its bottom in October 1996 (37 Birr per quintal) considering since the last seven years. The farmers were responding to this problem by reducing the area under the improved practices. Accordingly, 32% of the sample adopting farmers were identified reducing their maize area under the improved practice by about 25%, but none of the non-adopters intended to do so.

Overall, the problem of lack of demand for the product and the seasonal price fluctuation must have emerged from the common problem of poorly developed infrastructure like road, market centre and market information that leads to inefficient market system. On the other hand, despite the inefficient market system in the economy as a whole (at least in the short run), the

Government has left everything for the market pertaining to the free market economic policy. Therefore, all problems related to the market system may crowd out the sustainable use of the improved maize technologies.

**4. High cost and unavailability of farm inputs**

While the prices of outputs have been declining, prices of farm inputs, particularly of fertilizer, usually increases over years. The improved practice is demanding high level of input use. The cost of inputs is exacerbated by the poor infrastructure, and by the absence of integration with the grain market system. Therefore, due to the high cost of the inputs in the improved practice, farmers' potential to use the improved practice may diminish.

The hybrid maize seeds are much more productive than the improved open pollinated seeds in the study area, and hence are highly demanded by the farmers. These types of seeds, however, cannot be produced and maintained by the farmers themselves. Rather it should always be multiplied by professionally certified organizations. Therefore, it implies that the farmers are supposed to buy the seeds every cropping season. Thus, seed has been changed from non-market behaviour (saving own seed for future sowing like it is in the case of the local seed) to market relation (buying approved seeds). However, the market for the improved seeds is not well developed. Improved seeds are not be available in sufficient amount in the open market for households who can afford to buy.

Thus, control on seed quality (ensuring genetic purity) and consistency of supply do not seem promising. Rationing the improved seeds as it is practiced today by the Government does not enhance sustainable use of the improved practices. This is because first it reaches only few farmers who have good access to the MOA offices, hence discriminate individual farmers. Secondly, farmers cannot have the opportunity to use the improved maize technologies bases at their economies of scale.

Therefore, it is noteworthy that farmers have been seriously constrained with shortage of improved seed just at the infant stage of the adoption process. So, the question is how to meet the increasing demand of the farmers for the improved seeds? The answer to this question is ambiguous, and largely depends on Government efforts and policies related to agricultural development.

**5. Problem of the resource poor farmers**

There will undoubtedly be difficulties in extending adoption of maize technologies to resource poor farmers (those who own less than 0.75 hectare and one or no ox at all). The SG 2000 project used to give farmers fertilizer and improved seed on credit with 50% down payment so as to enable them to participate in the extension activities. However, in the descriptive and probit analyses it has been indicated that the extension participating and/adopting farmers were relatively wealthier. Hence, it can be perceived that the credit service was biased against the poor farmers. Farmers who have benefited most from the adoption of the improved maize technologies are found to be relatively the better off ones. They have more access to farm inputs.

On the other hand, the resource poor farmers often have limited access to purchased inputs and hence are less likely to adopt. Thus, despite the considerable potential for increasing productivity in the area, the benefit of the new practices to the majorities of the farmers will probably be realized only gradually. Even this gradual adoption may be effective only if credit is facilitated in

# CHAPTER VI

# CONCLUSION AND POLICY IMPLICATIONS

## 6.1 CONCLUSION

Significant increase in agricultural productivity is required to improve food security and quality of life. Such a break through depends on the organization and arrangements by which more productive germplasm, inputs and practices are identified, developed and ultimately acquired and used by farmers. A well deigned investment in disseminating information on agricultural technologies can contribute greatly to increase productivity of farm resources. Several measures had been taken towards improving agricultural productivity in Ethiopia in which different technology extension approaches were practiced all involving considerable costs in the extension organization. Any extension approach is justified only if it enables the farmers to use the improved technologies and then improve farm productivity.

In this regard, the SG 2000 Extension Project has been heavily involved in transferring improved maize technologies to farmers, among others, to increase the level of farm productivity. The extension system has been designed in such a way that farmers get the opportunity to participate in the technology diffusion and evaluation using their own farm lands. This case study was conceived first to evaluate the determinants of extension participation. And then it has attempted to quantify the impact of the SG 2000 extension project on farmers' level of technology awareness and adoption, and improvement in productivity of maize. To this end the Probit model and the Two-Stage Switching Regression Cobb-Douglas Production Function were applied on data collected from 225 sample farm households in the Bako area.

The result revealed that household characteristics, resource endowment and other socio-economic variables have been affecting farmers' participation decision in the extension. Education level of the household head, proximity to the main road, size of land and number of oxen owned, availability of credit for down payment and market risk aversion significantly affected farmer's decision to participate in the extension program.

The extension project has resulted in a strong impact on farmers' awareness of the improved maize technologies. Significant number of both the sample SG and the sample NSG farmers were aware of almost all of the recommended and transferred practices. The project also induced a strong demand for the technologies. Nearly all sample SGs adopted the improved maize technologies though the adoption by the NSGs was minimal (10%). Under the prevailing circumstances, the number of NSG predicted to participate (likely to adopt) is about 24%.

The difference between maize productivity of SG and NSG is assumed to be because of extension program since the groups become homogeneous after endogenous selectivity bias is eliminated. Thus, despite the low adoption rate of the NSGs, the diffusion of the improved maize technologies by SG 2000 extension project has resulted in enormous impact in increasing maize productivity over the traditional practice. The econometric analysis of the production function showed that there appears significant improvement in farm level maize productivity. Particularly, the output elasticity coefficients of fertilizer and labour for the SG are significantly greater (at 10% level) than the coefficients of these inputs in the NSG. The marginal product of all the inputs used in the analyses are also much higher under the improved practices than under the traditional practices. Further more, the extension project has resulted in an increase in productivity (estimated gross benefit) of about 37.25 quintal per hectare. Therefore, owning to the upward shift in the production function, a greater area of land per farm household and more intensive use of particularly labour and fertilizer could be possible.

The cost-benefit analysis also showed that the use of the improved practices is more profitable than the traditional practices of maize production. Considering different scenarios of cost accounting in the improved practices, the net benefit for the SG ranges from 726.46 to 1267.48 Birr per hectare, and accordingly the MRR ranges from 36% to 213%. In addition, the VCR of fertilizer and the improved seed are estimated to be 3.13 and 12.76 respectively. On the other hand, the net benefit for the NSG from the traditional practices is only 385.60 Birr per hectare.

Therefore, the prospect of improving productivity of maize by farmers is limited by the availability and proper diffusion of improved technologies compatible to the farming circumstances. This is because pertinent delivery of improved input coupled with adequate extension services to the small farm households has increased farm productivity and net return under the existing situation of the study area. Hence the believe that farmers should use more research information and higher input levels to produce more food is supported by the result of the study.

However, for similar reasons as in the case of extension participation, considerable number of the sample households who had not participated in the extension did not adopt the improved maize production technologies. The principal problems and constraints were lack of financial means and inability of the farmers to afford the cost of the improved inputs, shortage of oxen and/or land, unavailability of the improved technologies and instability of output price. Credit was not facilitated to adequately induce the poor to involve in the extension activities. Market is unreliable and poorly functioning for both output and input. Thus, currently the overall proportion of sample farmers who have been using the improved technologies is small. This implies that much of the areas cultivated for maize was under the traditional subsistence farming, that is, majority of the farmers continue to use their traditional practices.

The challenge is, therefore, to enhance adoption of the improved maize technologies and guarantee its sustainable use. Hence, there are strong indications that great efforts have to be made to meet the current and the predicted demand for improved practice, and to further encourage the use of maize technologies on sustainable base.

In this regard, transforming the traditional mode of production to the improved mode of production largely lies on the agricultural development policies. The Government should create conducive socio-political environment and appropriate policy measures to promote technically valid extension approach. If special support system is supplemented to accelerate technology adoption correcting the undesirable distributive effect of technological changes on the poor, following the SG 2000 extension approach will have a bright future to improve the welfare of the farm household.

## 6.2 POLICY IMPLICATIONS

### 1. Subsidizing and facilitating credit service

It has been noticed that very low proportion of the NSGs were adopting the improved maize technologies. Lack of financial means and inability to afford the high cost of the inputs, and poor endowment of land and/or oxen are among the reasons mentioned. On the other hand, enough time had not been given for wider technology adoption before subsidy on inputs was absolutely eliminated. This implies disregarding to consider farmers' ability to afford the high cost of improved farm inputs.

However, if subsidy is made on inputs mainly on fertilizer, it directly benefits more of the rural small scale farmers who are the majority of the society. Without disregarding the ill effects of subsidies on resource allocation and other macroeconomic and microeconomic parameters, *temporary* subsidy is usually suggested to accelerate technology adoption and to raise the level of farmers' financial position to the level they can help themselves without subsidy after some time using the technology. The works of Ellis (1996) indicated that temporary subsidy on improved farm inputs is vital until sizable adoption is realized, and the benefit that can be generated from adoption of high yielding technologies is much greater than the costs to the society.

However, the idea of input subsidy is faced with arguments among economists in that input subsidy causes farm-level distortion of resource allocation (by changing relative prices between inputs) and leads to depletion of Government budget. In this regard, subsidy on credit helps to avoid distortion in farm level resource allocation.

It was also noted that in the econometric analysis of adoption credit availability for down payment was found to be the most important determinant of adoption of the improved maize technologies in the Bako area. Moreover, due to lack of oxen and/or land the sample households were not able to participate in the extension activities, and hence not adopted. Credit enables farmers to acquire these inputs through either purchase or hire and they may be able to adopt and increase the use of the improved inputs. Thus, subsidized credit should be provided to the farmers. Here, a special focus should be made on the resource poor farmers, and credit should not be limited only to the variable inputs. This is because the poor farmers need credit primarily to purchase basic capital assets like oxen without which it is less likely for them to use the improved technologies. Therefore, both short run and a long run credit should be designed and facilitated to support the poor farmer from the grass root level to enhance adoption of the improved technologies.

**2. Output Price Support**

In an economy where infrastructure and market integration is not well developed (to allow free price policy) individual farmers who are operating under high input costs cannot escape incidence of risk of substantial loss due to price fluctuation. To the extent that farmers are risk averse, which when added to uncertainties, deters investment on new production techniques.

The problem of unpredictable market environment (market risk and uncertainty) can be mitigated mainly through timely and accurate market information. In the absence of promising market, production using improved but high cost inputs will not be sustainable. There will only be truly sustainable gains from technology use if consumers are allowed to benefit from lower food price while producers simultaneously earn adequate margin to maintain profitability.

Improved market information and forecasting system should be widely disseminated. However, this cannot be an immediate solution for the market problem farmers are currently confronted with. Thus, pricing policy that guarantee producers to pay off their input cost and pay off attractive profit and still can generate consumer surplus will have to be established. Otherwise, adoption of the improved technology by farmers may be very slow and uneven if left entirely to the market forces, and further attempt to diffuse the maize technology may result in considerable social cost.

In such cases, output price support is justified because of its effect on the adverse microeconomic effects like uncertainties created by price movements. Moreover, output price support has a less distortion effect on input allocation relative to input subsidy. Indeed, it is a temporary policy only in order to ensure that farmers take advantage of the potential rises in productivity that become available to them; otherwise farmers may adjust fully and would lead to inefficient use of resources (Ellis, 1996). Hence, price incentive should be meant only to reduce the largest price fluctuations, but allowing domestic prices to move freely.

In general, it should be underlined that the intention of suggesting incentives for farmers (credit subsidy and output price support) is to make them jump from the traditional to the improved production practices.

**3. Encourage intra-regional trade**

Very related to price support is improving intra-regional trade of the product. The potential for intra-regional trade from surplus to deficit areas has to be facilitated. It improves market for the product by increasing demand for the producers and supply for the consumers. In doing so, intra-regional trade may even increase food security that benefits both producers and consumers of the crop, and so the society as a whole. In this regard, improving infrastructure and market information systems becomes essential to improve the efficiency of market performance.

## 4. Improving input supply

To meet current demand for improved maize technology and given the forecast for increased adoption, supply of inputs mainly that of improved seeds should be raised. Seed supply can be improved by increasing areas and the management of seed multiplication sites. In this case, due consideration has to be given in taking care of the genetic purity of the improved varieties so as to maintain their productivity. Encouraging private investors, Research Institutes and other concerned organizations will have greater role.

## 5. Infrastructure development (specially road and school)

The analysis showed that distance to the main road and level of education have strong effect on farmers extension participation. It is because proximity to all-weather roads enables farmers to be more accessible to information on improved technologies, and to input and output markets. Similarly, the ability to read and write would imply greater access to information and thus faster to use the new technologies. Therefore, improvement in infrastructure would help much to accelerate technology use and then improve farm productivity.

## 6. Encouraging further research

It is always useful to develop and generate relevant technologies (supplementary or complementary to the available technology) that farmers can adopt. This is helpful for sustainable use of modern inputs. Thus, Government has to create conducive environment to ensure the capability of the Research Institutes to continuously develop relevant technologies. Main areas of research suggested are:

*a) Development of improved seeds and better storage systems*

One should not entirely depend on the developed improved varieties. It is always vital to undertake further research to generate streams of improved seeds to secure producers from risk that may arise due to pests, diseases, and genetic deterioration of the current ones. There could also be a room for further genetic improvement for yield and/or other desirable qualities seeds. Improved storage systems should also be focused to enable farmers and consumers to use the product over a long period of time.

*b) Irrigation technology*

Moreover, the performance of agriculture in general and that of maize in particular is still highly dependent on weather conditions with most of the farmed area being rainfed. It becomes important to look into irrigation potential, and research into irrigation technology to have a high return over year and to minimize output and price risks associated with weather changes.

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# APPENDIX

## THE IMPACT OF AGRICULTURAL EXTENSION ON MAIZE PRODUCTION: A CASE STUDY OF SG 2000 EXTENSION PROJECT IN BAKO AREA

*A Questionnaire*

Farmer's name________________________________

Farmer type: 1. SG-2000 paticipant 2. Non-participant

Farmer number________________________________

District________________________________

Peasant Association ________________________________

Distance from the main road (walking hr) ____________

Date________________________________

Enumerator________________________________

Supervisor ________________________________

**Instruction to enumerator**

Please introduce yourself before starting questioning the farmer by name, location, the research centre you are working for and its purpose and objectives. Ask each question patiently until the farmer gets the points. For open questions fill the farmers' response in short and for closed ones indicate by ticking (v)or encircling.

## A. BACKGROUND INFORMATION

### 1. Household characteristics

1.1 Household head sex 1. male 2. female

1.2 Household head age ________________

1.3 Household head level of education:

0 = illiterate 1) grade 1 - 6 2) grade 7 - 8 3) grade ≥9

1.4 Household size ________________

1.5 Number of adults living in the household over 17 year______

1.6 Number of children 12 to 17 years ________________

1.7 Number of children less than 12 year______________

### 2. Land

2.1 Total farm size____________oolshaa (1 oolshaa = 1/5 ha)

2.2 Land under cultivation__________oolshaa

2.3 Fallow _____________oolshaa

2.4 Grazing area____________oolshaa

2.5 Other (specify)___________oolshaa

2.6 Have you ever rented in/ out land? (circle one).

1. yes 2. no

2.7 If yes, when did you start to rent in/out(circle one) 19_____________

2.8 Have you ever sharecropped in/out (circle one)?

1. yes 2. no

2.9 If yes, since when? __________________

### 3. Crops grown this year (1997)

| Crop | Total area (oolshaa) |
|---|---|
| maize | ____________________ |
| tef | ____________________ |
| pepper | ____________________ |

noug ____________________

other (specify) ____________________

## B KNOWLEDGE AND PRACTICE OF IMPROVED TECHNOLOGIES

**(improved seed, planting method and fertilizer application)**

**4. Seed**

4.1 What kind of seed (variety) of maize have you planted since 1994?

(if improved = 1, if local = 2)

| Year | improved | local | Area (improved/local) |
|---|---|---|---|
| 1994 | 1 | 2 | --------- |
| 1995 | 1 | 2 | --------- |
| 1996 | 1 | 2 | ---------- |
| 1997 | 1 | 2 | ---------- |

4.2 Improved varieties and their areas in 1997:

| Variety | area (oolshaa) |
|---|---|
| 1. BH 660 | _____ |
| 2. BH 140 | _____ |
| 3. Beletech | _____ |
| 4. Pbh 3435 (pioneer) | _____ |
| 5. Pbh 3153 (pioneer) | _____ |
| 6. local | _____ |

4.3 What was your source of seed?

1. SG-2000 or MOA
2. research team
3. purchased from local open market
4. retained from own harvest
5. Exchange from neighbour
6. other (specify)

4.4 If you have not ever used improved maize seed, why?

1. not heard or not aware
2. too expensive to buy
3. not available
4. not better than the local ones
5. other (specify)

**5. Planting**

5.1 What planting method did you use?

1. row planting
2. broadcasting

5.2 If you used row planting method, when did you start? 19________

5.3 What seed rate did you use?

for row planting ___________kg/oolshaa

for broadcasting____________kg/oolshaa

5.4 Do you know the recommended seed rate?

1. yes 2. no

5.5 If row planting, what is the spacing between rows and between plants

Between rows _________________(specify the unit)

Between plants _________________(specify the unit)

5.6 If you did not apply the recommended seed rate and/or spacing, why?

1. not aware
2. labor shortage
3. land/oxen constraint
4. risk avoidance
5. orther (specify)

5.7 Did you apply pesticide (marshal chemical) on your maize farm?

1. yes 2. No

5.8 If not, why?

**6. Fertilizer**

6.1 Did you apply fertilizer on maize in the following years?

| | YES | NO |
|---|---|---|
| 1994 | 1 | 2 |
| 1995 | 1 | 2 |
| 1996 | 1 | 2 |
| 1997 | 1 | 2 |

6.2 If yes, average amount you have used since the last three years

DAP _______________(kg/olshaa)

UREA _______________(kg/oolshaa)

6.3 Do you know the recommended fertilizer rate?

1. yes 2. no

6.4 Do you apply the recommended rate? 1. yes 2. No

6.5 If no, why?

1. too expensive
2. fertilizer is not available
3. cash shortage
4. recommendation rate is not profitable
5. other (specify)

6.6. What method did you use to apply fertilizer?

1. spot application
2. drilling in rows
3. broadcasting
4. side dressing
5. other (specify)

6.7 If you have not applied fertilizer using spot application method, what is the reason?

1 labour shortage
2. it does not increase productivity
3. unaware of the method
4. other (specify)

## C. FARM LEVEL AND INCOME RELATED EFFECTS OF USING THE IMPROVED TECHNOLOGY, IF ANY!

**7. Labour utilization**

7.1 Is there any change in family labour requirement in maize farm operation since the last three years?

1. yes  2. no

7.2 If yes, on which operation?

1. land preparation  3. weeding
2. planting  4. harvesting

7.3 Do you hire labour?

1. yes  2. no

7.4 If yes, mention the year(s)

7.5 If yes, for which operations (1996/97)?

| | total mandays | cost (birr/ day) |
|---|---|---|
| 1. ploughing | ________ | ________ |
| 2. planting | ________ | ________ |
| 3. weeding | ________ | ________ |
| 4. harvesting | ________ | ________ |
| 5. threshing and storing | ________ | ________ |

7.6 If you do not hire labour, why?

1. have enough family labour
2. no labour available to hire
3. too expensive
4. other (specify)

**8. Maize production and its utilization**

8.1 What is the trend of your maize production area since the last five years?

1. increasing 2. decreasing 3. same

8.2 If increasing, how?

1. increase on own land
2. sharecropping (in)
3. sharecropping (out)
4. rented land (in)
5. other (specify)

8.3 Did you plant all of your maize area with improved seeds?

1. yes 2. no

8.4 If not, why?

1. Cash sortage to purchase seeds and fertilizer
2. improved seed is not adquately available
3. to avoid risk that may be associated with the new practice
4. To reserve the local varieties
5. other (specify)

8.5 If maize area has been increasing, has the area of other crops decreased?

1. yes 2. no

8.6 If yes, of which crops? ________________________________

8.5 Quantity of **maize** grain harvested and sold in:

| | **1995** | **1996** | **Remarks** |
|---|---|---|---|
| total harvested (qt) | _______ | ________ | _______ |
| total sold (qt) | _________ | _____ | ______ |
| price (birr/qt) | ______ | _______ | _____ |

## 9. Livestock

9.1 Do you have any of the following livestock?

| **type** | **number** |
|---|---|
| oxen | __ ______ |
| cows | _________ |
| heifers | _________ |
| calves | _________ |
| sheep | _________ |

goats ________
mules ________
horses ___ ____
donkeys ________

9.2 Are your oxen enough for your farm operation?

1. yes 2. no

9.3 If no, means to get additional oxen;

1. borrow
2. exchange with labour
3. hidhata/maqanajo
4. hire/cimaadaa

## D. AGRICULTURAL SUPPORT SERVICES, IF ANY!

### 10. Access to agricultural information

10.1 Have you ever attended any of the following:

| | <u>No. of days</u> | <u>month/year</u> |
|---|---|---|
| 1. field day or demonstration | ________ | ________ |
| 2. farm training course | ________ | ________ |
| 3. agricultural program on the radio | ________ | ________ |

10.2 Have you ever been visited by extension agent?

1. yes 2. no

10.3 If yes, during which operation?

1. ploughing 3. weeding
2. planting 4. harvesting

10.4 Do you have experience with Bako Research Center?

1. yes 2. no

10.5 If yes, in what activity(ies)?

1. Demonestration
2. on-farm verification

3. other (specify)

**11. Access to credit**

11.1 Did you get credit for down payment to use the improved technologies?

1. yes 2. no

11.2 If yes,

| **source of credit** | **interest** |
|---|---|
| Neighbour/relatives | ____________ |
| local money lenders | ____________ |

11.3 Did you pay back the money you got on credit?

1. yes 2. no

11.4 If no, why____________________

11.5 Do you need credit for your future farm activities?

1. yes 2. no

11.6 If yes, for what purpose?____________________

11.7 If you do not get credit, what is your problem?

1. not available
2. lack of low cost (low interest)
3. guarantee (collateral) problem
4. other (specify)

**G. PROBLEMS**

12.1 Has your family ever faced food shortage?

1. yes 2. no

12.2 If yes, what are the reasos?

1. land shortage
2. oxen shortage
3. labour shortage
4. poor productivity

5. other (specify)

12.4 Do you face any problems in selling your maize?

1. yes 2. no

12.5 If yes, what type of problems?

1. low price

2. lack of transport

3. other (specify)

12.6 What other problems do you have in maize production?

1. ____________________

2. ____________________

3. ____________________

4. ____________________

5. ____________________

12.7 What measures have you taken to alleviate some of the problems mention in question 12.5 and 12.6?

____________________

____________________

12.8 What is your future plan for maize production?

1. ____________________

2. ____________________

12.9 What do you suggest the government should do to encourage maize production?

1. ____________________

2. ____________________

12.10 What do you do to improve your maize production?

1. ____________________

2. ____________________

## E. OFF- FARM ACTIVITY

13.1 Do you/your family work off-farm?

1. yes  2. no.

13.2 If yes,

| Who | where | type of work | payment/day |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |

## F. RELEVANCE OF THE SG 2000

14. How do you rank the SG 2000 extension recommendations?

1. highly applicable
2. applicable
3. not applicable

## **Smallholder' Maize Production Record** (1996)

Location______________________________

Area of maize field_______________oolshaa

Soil quality (1) poor (2) fair (3) good

Fertilizer per Oolshaa: DAP ______ kg, UREA ________ kg.

Seed: type ____________, seed rate _______kg/Oolshaa.

**Table 1. Labour hours required for different operations in maize production (1996)**

| Operation | total labourers | | time start | time finish | total time |
|---|---|---|---|---|---|
| | SG/ Adopter | NSG/Non adopter | | | |
| **1. Ploughing:**<br>1st<br>2nd<br>3rd<br>4th<br>5th | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| **2. Planting:**<br>Seeding<br>Fertilizing | | | | | |
| | | | | | |
| | | | | | |
| **3. Weeding:**<br>1st hoeing | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| 2nd hoeing<br>Babaqaa<br>Moccoraa<br>Carabaa | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| **4. Harvesting**<br>Cutting & piling<br>Dehasking & transporting<br>Threshing & storing | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| **5. Other** | | | | | |

Note: Identify the number of labourers used in each operation for both Column 2 and 3 by age group and sex.
Age group: 1 = 10_13, 2 = 14_16, 3 = 17_50, 4 = >50 years

Total labour hours for all operations ____________
Total oxen hours for all operations ______________

Note: Average local wage rate per labour day_________birr
lunch type_______________________, estimated cost________birr
Average local hiring rate of a pair of oxen per day _______ birr
Average ox hire (cimaadaa) per one crop season_______birr

__________________________________/////__________________________________

## DECLARATION

I, the undersigned, declare that this thesis is my work and all the sources of the materials used for the thesis have been duly acknowledged.

Name Beyene Tadesse

Signature