UNIVERSITY OF CAPE COAST

SMALL SCALE MAIZE FARMERS AND APPLICATION OF IMPROVED AGRICULTURAL TECHNOLOGIES: A CASE STUDY OF EJURA-SEKYEDOMASI DISTRICT OF GHANA.

By

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A thesis presented to the Centre for Development Studies, Faculty of Social Sciences, University of Cape Coast in partial fulfilment of the requirements for the degree of Master of Philosophy in Development Studies.

September, 1996

CANDIDATE'S DECLARATION

I hereby declare that, this thesis is the result of my own original research and that no part of it has been presented for another degree in this University or elsewhere.

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SUPERVISORS' DECLARATION

We hereby declare that the preparation and presentation of the thesis were Supervised in accordance with the guidelines on Supervision of thesis laid down by the University of Cape Coast.

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ABSTRACT

This thesis examines the issue of small scale farmers' application of improved agricultural technologies. The study concentrates on small scale maize production, a major rural activity in Ghana, and seeks to assess farmers' supply response resulting from the application of improved maize production technologies.

Several studies on farmers' supply response exist. However, most of these studies often concentrated upon farmers' response to price changes hence the exclusive focus on price factors as the major variable in explaining farmers' supply responses.

This present study posited that "non-price" factors in particular application of improved technologies are major determinants of agricultural supply. Three improved maize production technologies, namely, planting of improved variety (I) application of chemical fertilizer (II) and tractor ploughing (III) and combinations of these technologies were investigated.

Results of the survey revealed that: first, the planting of improved variety (I) was the most commonly applied of the improved maize production technologies. Second, the prevailing government economic policies were the most important factor influencing the levels of application of improved maize production technologies. Fifty eight per cent of the respondents applied the combination of all three technologies (I + II + III), 22 per cent applied two out of the three technologies (I + II, I + III, II + III) whilst 20 per cent applied only one. Third, the application of the improved maize production technologies (I, II and III) did not significantly influence the quantity of maize supplied (QS). Rather, gross margin (GM) and farm size (R) were the significant factors that influenced the quantity of maize supplied (QS).

The study thus shows that small scale maize farmers in the study area need to be encouraged to improve on their farm sizes. Government should also provide the requisite education and demonstration through the development of stronger relationship between small scale farmers and extension agents.

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LIST OF ABBREVIATIONS

CASIN	Center for Applied Studies in international Negotiations
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	Centro International de Mejoramiento de Maizy Trigo (International Maize and Wheat Centre) Mexico.
CRI	Crop Research Institute
ECA	United Nations Economic Commission for Afirca
FAO	Food and Agriculture Organization of United Nations.
FLS	Front Line Staff
GGDP	Ghana Grains Development Project
GLBD	Grains and Legume Development Board
IFAD	International Fund For Agricultural Development
IFPRI	International Food Policy Research Institute
IITA	International Institute for Tropical Agriculture.
MOFA	Ministry of Food and Agriculture

OECD	Organization for Economic Co-operation and Development.
OAU	Organization of Africa Unity
PPMED	Policy Planning Monitoring and Evaluation Division.
SAA	Sasakawa Africa Association
SG 2000	Sasakawa Global 2000

CHAPTER ONE

INTRODUCTION

1.1: Rationale for the study

Food deficit is a major development problem in Sub-Saharan Africa (Acharya, 1994, Diouf, 1990, Von Braun and Paulino,1991,). Recent statistics show that Africa is the only continent where per capita food production is declining, to the point of being a serious concern to the world community. Two decades ago, the average growth of agricultural production in Africa was 2.4 per cent per annum while its population was increasing at 2.6 per cent per annum. By 1987, the growth rate of agricultural production had fallen to about 1.3 per cent per annum, while the population growth rate had climbed to 3.1 per cent (Diouf, 1990).

This situation has brought about important consequences. Firstly, Africa is no longer able to feed its people. According to the World Bank, about 20 per cent of the region's population is undernourished (Sinkam, 1988). Dietary energy supply is believed to have fallen below the level required in at least 27 African countries. In some of these countries, the nutritional deficiency in terms of daily per capita food supply has been as high as 12 per cent annually (ECA, 1987). This has exposed a growing number of the people to lethal diseases such as Xerophthalmia, goiter, and cretinism (Trant, 1989), with some of the victims dying in excruciating circumstances. The stark reality of this fact - portrayed through televised images of starving children - has had an impact upon the world's affluent societies, giving an ethical dimension to the problem.

Robert Macnamara, former president of the World Bank captured the essence of this crisis when he declared in the Sir John Crawford Memorial lecture (Washington, D.C. 1985) that:

> *"The harsh truth is that sub-Saharan Africa today faces a crisis of unprecendented proportions. The physical environment is deteriorating. Per capita production of food grains is falling. Population growth rates are the highest in the world and rising. National economies are in disarray. And international assistance in real terms is moving downwards". (Hansen, 1989).*

In the face of such shrinking food production, the region has been confronted with three options. One, to direct scarce foreign exchange earnings to the importation of food. Second, to rely on food aid and third, rely on improvement in local food production. For instance, since 1960, the region's food imports (mainly cereals) have increased eight-fold (FAO, 1986). Between 1974 and 1987, despite a three-fold increase in food aid, the cereal import doubled to over US$ 1 billion. In 1989, the volume of food cereals imported was 8.2 million tonnes. This jumped to 11.4 million tonnes in 1991/92. In value terms, the region's annual food import (including cereals) are equivalent to roughly 30 per cent of its agricultural export earnings (OAU, 1984). The cereal import in 1989 alone cost the region about US$ 1billon (ECA, 1989). Over the years, the region's food import dependency ratio (net import expressed as a percentage of total domestic supply) has increased. And the region's inability to cope with rising food imports has necessitated a mounting volume of food aid. Thus, for instance, with less than 15 per cent of the world's population, the region has until recently received 50 per cent of all food aid flows to developing countries (FAO, 1990). It is reported that Ghana spends on the average ¢150 million in importing "food and live animals" per annum since 1975 (Micah and Adei, 1989). These options, have of necessity, been resorted to in desperate effort to meet the region's food demand which has been expanding at an annual rate of 2.9 per cent since 1960 (Yaker, 1993). However, there is very little room to increase this volume since most of the countries in the region are facing chronic balance of payment deficit.

Secondly, evidence available in literature indicates that food imports pre-empt a good part of the import capacity of the country leaving little for investment in industry and this adversely affects the pattern of industrialization.

Furthermore, Schneider (1984), in his work "Meeting Food Needs in a Context of Change" has asserted that food imports adversely affect consumers. Schneider argued that the immediate positive effect of low priced imported food may be replaced by hardship of high priced food in the future if there is an upward trend in world market price or concessional food supplies are discontinued. In the meantime the opportunity for increased domestic production and increased productivity may have been forgone because of the depressing effect of cheap food imports. Imported food, though may offer the consumer a greater chance of meeting their dietary requirements, it may not take into account its nutritional quality. Concluding, Schneider (1984), mentioned that food import sometimes seems to be part of self-reinforcing "vicious circle of underdevelopment", since the satisfaction of increased urban food needs through imports depresses domestic agriculture, which in turn lead to further urbanization via rural-urban migration and to further increases in food import and external debts.

Food aid helps to improve nutrition, since it transfers one of life's most basic requirements from places of plenty to people who do not have enough. However, the dependence on food aid as an option is not without problems. Several detrimental effects of food aid on agricultural production of recipient countries have been identified and reported in literature.

Food aid, for instance, is reported to have an adverse effect on agriculture since it provides an alternative cheap source of food for marginal farmers, who are thus, enabled to neglect cultivation (Schneider, 1978).

In the short term, food aid is also asserted to depress food prices, make internal terms of trade turn against local production, and increases the tendency to reduce production except in subsistence farmers. Depressed prices, imply income increase for consumers, as a consequence demand increases, further unleashing negative effects on prices and output.

Among the long term detrimental effects of food aid on reciepient countries identified in literature include the following:

- increasing dependence on food aid.
- if there are insufficient alternative production possibilities in agriculture, a lasting damage will result in this sector.
- prevention of the introduction of improved production

technologies.

- tendency to increase rural-urban migration and its attendent problems.
- possibly damage to domestic producers because of distablized market conditions.
- undue political manipulation and interference in the socio-economic development of recipient countries (Schneider, 1978).

On the basis of the foregoing, it can be clearly seen that food imports and food aid are not the best options open to African countries, if they are to overcome their food deficit problems. The only viable option for developing countries, particularly those in Sub-Saharan Africa to break out of the food dificit problem is to strengthen their own domestic agriculture.

In Ghana (true for most of the countries of sub-Saharan Africa), most of the agricultural production activities are carried out by small scal farmers (IFAD,1993, Hansen, 1989, Brown, 1989). Though the definition of "Small Scale Farmer" has been the subject of much debate, it still remains fuzzy (Valdes et al 1979, Wharton, 1969). A precise definition, however, is not required to recognize their importance in the economy. According to IFAD (1993), about 95 per cent of the total food production in Ghana originates from small scale traditional farming. The small scale producer, according to IFAD (1993), cultivates more than a plot of land and usually has holdings smaller than 1.6 hectares (4 acres) and

2 hectares (five acres) in Northern Ghana. They constitute about 76 per cent of all land holders and cultivate 44 per cent of the total cultivated land. In addition, small scale farmers form the bulk of the rural population and they generally have low incomes and low standard of living.

Among the major categories of food crops produced by the small scale farmers in Ghana are grains and cereals. Within this category maize has been identified as the most important. Maize is one of the staples of Ghanaians. It is cultivated on more than 500,000 hectares and across all agro-ecological zones in Ghana. (GGDP, 1991). The crop constitutes a rich source of carbohydrate both for human and animal nutrition. In humans, it is consumed in a variety of forms including different types of fermented steamed maize dough, porridge, gruels and cooked or roasted green ears. It also features prominently in infant weaning food country-wide. In animal nutrition, maize is presently the main energy source in non-ruminant feeds. It averages 50-60% by weight of the total feed and provides much of the energy requirement. The production and marketing of the crop also constitute a major source of employment and income to farm families across the nation because of its reasonable ease of production and existence of marketing channels from production centres to urban centres where the bulk of consumers are concentrated.

The critical importance of maize to food self-sufficiency and food security in Ghana is reflected in the establishment of the Ghana Grains Development Project (GGDP) in 1979. - a joint venture between the government of Ghana, and Canada and being implemented by the Crop Research Institute (CRI), the International Maize and Wheat Improvement Center (CIMMYT), with the Ministry of Food and Agriculture (MOFA), the Grains and Legume Development Board (GLDB) and the International Institute of Tropical Agriculture (IITA) as cooperating bodies (GGDP, 1991). Substantial investments have been made by GGDP in developing improved maize production technologies. Many high-yielding varieties, disease resistant varieties, varieties with different maturing periods etc, mostly a selection from crosses involving traditional and introduced varieties and/or their re-selections have been tested in regional, multi-locational and on-farm trials. Some of these varieties have been released to farmers in the maize producing areas (see Appendix A: Table 1.1). Other improved maize production technologies have also been made available to farmers. (see Appendix A: Tables 1.2, Appendix A: Table 1.3 and Appedix A:1.4). Furthermore, since the early parts of the 1980s, annual maize and cowpea workshops have been organized by the CRI to equip extension officers and farmers with information on developed improved maize technologies. Non-governmental organizations such as Sasakawa Global 2000, World Vision International etc are also actively involved in the dissemination of information on these improved technologies to farmers. In addition, seeds of improved varieties have been made available to farmers through several channels. The Ghana Seed Company was established in 1979 and was responsible for producing and distributing maize seeds until 1989 when it stopped operating. The GLDB also produced seeds of improved maize varieties and made them available for sale through the boards's staff who are based in towns and villages throughout the country. Extension agents from MOFA have also distributed or sold improved varieties to farmers with whom they work. In recent years, SG.2000 has both purchased and produced seeds of improved maize to make available to farmers as part of their loan and demonstration programme. Currently with the advent of trade liberalization, seeds of improved maize varieties and other inputs particularly agro - chemicals - fertilizers and pesticides - are now sold by private individuals in the open market scattered throughout the towns and villages of the country. Inspite of the availability of these improved maize production technologies evidence exists to show that there is an unshrinking gap between small scale farmers agricultural practices and those recommended by the research stations (GGDP, 1991).

To address the problem of food deficit and at the same time improve the levels of income and subsequently the standard of living of the small scale farmers calls for the adoption of strategies that embody the dual objective of increasing food production and improving the income generating capacity of the small scale farmers. The adoption of improved agricultural production technologies has been recognized as one of the major strategies (Mckenzie, 1988, Mellor, 1988, CGIAR, 1995).

According to Mckenzie, (1988) "there is no doubt that technological change will become even more important, since productivity and comparative advantage for agricultural production will depend more on technology rather than natural resources". Mellor (1988), on his part, asserted that at present, the low purchasing power of the poor, mostly small scale farmers in many Third World countries means that they lack the means to buy more food at any price and that technological change in agriculture represents the best way to boast the purchasing power of the poor. Mellor (1988), further stated that, technological change in agriculture would not only raise the total level of domestic food supplies but would at the same time increase the ability of the poor to purchase such supplies. CGIAR (1995), on their part argued that improved agricultural technologies, improved infrastructure, better government policies and more education are necessary for improved food production and supply, but then, improved technologies is the most reliable source of higher productivity and this undoubtedly holds true for the next century. Furthermore, CGIAR (1995), emphasized that, increasingly, prudent government policies would encourage farmers and other producers to use these improved technologies and this among others, would lead to improved agricultural productivity and output. Increased food Supply has several implications. First, increased supply of food, all things been equal, would lead to a decline in real prices of staples - they would become affordable to more people, less of family budget would then be required for sustenance, and more would be available for a variety of other purposes. Second, increased supply of food, would raise the incomes of families engaged in agriculture. This would enable them to improve the quality of their own lives - a better diet, better housing, more education, more tools and so on. Furthermore, the additional demand for non-farm goods and services generated by the increased farm incomes would add to the incomes of others, who would in turn contribute to widening rounds of spending that increase the demand for goods and services throughout the economy. Again, increased agricultural earnings would lead to higher government revenues, which could be used to stimulate other sectors, notably industry or as capital for human resource development. In effect, higher incomes from the agricultural activities lubricates the whole process of economic growth and subsequently increased welfare of the small scale farmers in particular. However, the advantages of modern agricultural science and technology have not yet effectively reached at least a billion small scale farmers located throughout the world (Leagans, 1979). A more sympathetic understanding of the conditions that persuade such farmers to accept agricultural innovations could facilitate increased food production as powerfully as the new technology itself. Again, many government development plans, policies and projects geared towards improvement in small scale agriculture and subsequently the welfare of the small scale farmers have emphatically failed to make their expected impact on the course of development. These failures, according to Carr (1982) have sometimes occurred because the fundamental features which characterized small scale or peasant agriculture - relating to its physical and economic endowments, the objectives and priorities of its farm families and the peculiar constrained environment in which it operates - have not been understood by policy makers, and planners at planning and project levels. Without this understanding, agricultural planning and agricultural policies, though they may accord with government objectives, will make little or no sense at the farm level

(Clayton, 1983). It is highly desirable, therefore, for policy-makers to have some views about small scale farmers' behaviour and farmers' response to economic and non-economic incentives. But, again, this will require an awareness of the factors which, at the farm level, influence or constrain farmers' decisions and actions, and an insight into the objectives the farmer and his family seek to achieve.

1.2: Statement of the problem

A number of socio-economic studies have been conducted in Ghana to determine farmers production constraints and application of improved maize production technologies. Results from these studies indicate that the application of improved maize production technologies by small scale farmers has been mixed, less optimistic than expected, despite the potential benefits expected from application mainly in terms of increased yields. From the current low levels (5-6 maxi bags per acre), a potential increase to 22 maxi-bags per acre may be expected (GGDP, 1994; Dankyi and Appau, 1990). These varying levels of application imply that farmers attach different relative importance to the recommended improved maize production technologies and hence the varying quantities of maize supplied to the market by small scale farmers even within the same locality.

Several factors such as farm size, the type of land tenure, the scale of production, inputs and credit availability, access to output market, storage and distribution facilities, farm labour, farm machinery, and so on have been hypothesized to be associated with the application of improved agricultural technologies by farmers (Feder, Just and Zilberman, 1985).

Despite the considerable research and attention given to the issue of the application of improved agricultural technologies, a consensus has not been developed regarding the social and economic factors that lead farmers to apply improved agricultural technologies. Because of natural resources, cultural, political and socio-economic differences, the importance of factors affecting the application of improved agricultural technologies differ across countries. For example, a review of technology adoption studies by Heisey and Mwangi (1993), showed that factors influencing the application of improved agricultural technologies differ by location. On the basis of the foregoing, there is the need to conduct specific studies on the application of improved agricultural technologies in areas where extension and research programmes have been implemented to understand the important factors affecting application of improved production technologies in these areas.

Furthermore, despite the growing literature on supply response and the growing recognition of non price-factors, few researchers have ventured into modelling of non-price factors in agricultural supply analysis. The problems center on the quantifiability, provided that reliable data exists, of these factors and the fine-tuning that is required if the models are to capture the specific reality of the individual country or crop where the model is applied. Among the most common non-price factors encountered in empirical estimation are, investment in research and development, initial conditions related to production structure, land constraints, regulations, rate of urbanization, population densities, access to capital, agroclimatic conditions and external shocks, but not that much on technology has been investigated (Ogbu and Gbetibouo, 1990).

This thesis, therefore sought to ascertain the specific conditions of small scale farmers which influence their decision making process about whether or not to apply improved maize production technologies and subsequently examined the importance of the application of improved maize production technologies on the quantity of maize supplied to the market by these farmers.

In sum, this thesis examined the importance of the application of improved agricultural technology for promoting increased production by assessing maize production activities of small scale maize farmers in the Ejura-Sekyedomasi District of Ghana.

1.3: Objectives of the study:

The main objectives of this study were:

1. To identify the various improved maize production technologies that have been extended to farmers in the study area.
2. To determine the adoption levels and adoption rate of improved maize varieties, application of chemical fertilizer and tractor ploughing among small scale maize farmers in the Ejura-Sekyedomasi District.
3. To determine the relationship between technological practice of small scale maize farmers and the quantity of maize supplied.

4. To analyse findings.
5. Attempt conclusions and recommendations that may be useful in formulating future policy decisions on how to improve the rates of application of recommended improved maize production technologies and subsequently improve maize output levels.

This study specifically tested the hypothesis that:

"Small scale farmers respond significantly and substantially to technological practices that enhance the quantity of agricultural products supplied".

1.4: Definition of terms

Small Scale Farmer: In this study, a small scale farmer was considered as a farmer:

- owning or working on hired small family-based plots
- having farm size ranging between 2.0 acres and 10 acres
- depending largely on traditional methods of farming such as the use of simple farm tools - cutlass, hoe, hand plough and in many cases on raw human power provided mostly by family members.
- depending largely and directly on natural factors such as rainfall for their production.

Adoption: In this study a farmer was considered to have adopted a technology if he/she uses it to any extent on his/her farm (Ahmed, 1981, Feder Just and

Zilberman, 1985).

Adoption Rate: Was defined as the number of farmers using the technology as a percentage of the total number of surveyed farmers.

Adoption Levels: In this study,adoption level was defined as the number of technologies used (Akorhe, 1981, Nweke and Akorhe, 1983).

1.5 Importance of the study

It is hoped that the results obtained from this study will among others, provide information upon which the current knowledge of agricultural research at the National Agricultural Research System in Ghana and other maize producing areas in Sub-Saharan Africa especially regions of West Africa will be based. This is very critical indeed since agricultural development ultimately depends on the degree to which farmers especially the small scale farmers are willing and able to incorporate research findings into their farming systems and the degree to which researchers are willing to incorporate farmers felt needs into their research agenda.

Secondly, this study will provide useful and functional information for the better prediction of short-run domestic supply of maize in the country and based on the predictions, the appropriate strategies to put in place.

Thirdly, it is only with knowledge of the responsiveness of agricultural product (maize) supply that the effects of various specific policies on agriculture and overall economic growth and development can be responsibly examined and the necessary corrective measures put in place.

Furthermore, this study will provide useful and functional information for predicting the farmer behaviour and for designing strategies to influence innovative responses. The information will assist officials of the Ministry of Food and Agriculture (MOFA) in formulating policies and programmes which are responsive to farmers local needs. Such information, it is hoped, will also be useful to non-governmental organizations playing vital roles in agricultural and rural development in Ghana.

Finally, this study will also contribute to the body of general knowledge on supply responsiveness in the agriculture of developing countries. Specifically, by incorporating technology and gross margin analysis into the agricultural response equation model, this study provides a methodological approach to studying small scale farmers' agricultural supply response behaviour.

1.6: Limitations of the study

This study is not immune to the general limitations inherent in research based upon interviewing techniques and semi-structured questionnaires. A major limitation of this study is that interviewers were used for the translation of questions from English to the farmers' local languages and reporting the farmers responses. It was assumed, at the onset of the study, that given adequate pre-training, the interviewers would be capable of correctly interpreting the meanings of the research questions for the mostly illiterate sampled farmers to understand and correctly interpreting and reporting farmers' responses in a clear and concise manner.

The data for this study were generated on the basis of the memory recall of the respondents. This constitutes another major limitation, because recall ability often varies widely with different farmers in terms of the possibility of farmers giving inaccurate answers to certain questions.

Another limitation of this study is the omission of certain explanatory variables. Inclusion of prices of other products, size of family as well as other technology specific characteristics and other socio-cultural variables would have further facilitated estimating the supply responsiveness of small scale maize farmers. The above limitation not withstanding, the factors selected and used in the response model were expected to provide enough information on the supply responsiveness of small scale maize farmers' in the Ejura-Sekyedomasi District of Ghana.

1.7: Structure of the dissertation

The dissertation is organized in the following way:

Chapter One provides an introductory overview of the whole study. Chapter Two, which follows, reviews the relevant literature on agricultural supply response. This review provides the conceptual framework and the relevant variables included in the supply response model(s) used in the study.

Chapter Three is in two parts. The first part presents the profile of the study area. Emphasis in this part is placed on the general background of the study area. The second part gives an indepth overview of the research methodology including the research design, the type and sources of data, data collection instrument and the procedure for collecting and analyzing the data. The empirical supply response model used for analyzing farmers supply responsiveness is also included.

Chapter Four presents and analyzes the empirical results of the study. In Chapter Five, the summary of the major findings, conclusions and implications of the results and suggestions for future research effort on this subject are presented.

CHAPTER TWO

SMALL SCALE FARMERS' SUPPLY RESPONSES IN FOOD PRODUCTION

2.0: Introduction

In order to specify models that are close to reality and thereby yield reasonable results, a full understanding of small scale farmers' behaviour in production and the way small scale farmers respond to improved agricultural technologies are important. They are essential ingredients in model specification for supply response analysis (Nerlove, 1958; Zanias, 1981, Wides and Dillion, 1978) and therefore are discussed in this chapter.

2.1: Small scale farmers' production behaviour

Discussions on the behaviour of small scale farmers in developing countries have often centered around their responsiveness to prices to which various hypotheses have been put forward. These hypotheses, however, can be conveniently divided into three major categories (Behrman 1968):

i. that small scale farmers respond quickly, normally and efficiently to relative price changes;

ii. that the marketed production of subsistence farmers is inversely related to prices:

iii. that institutional constraints are so limiting that any price response is insignificant.

The chief proponent of the first hypothesis was Schultz (1964), who argues that:

"The rate at which farmers who have settled into traditional agriculture accept a new factor of production depends upon its profit, with due allowance for risk and uncertainty and in this respect the response is similar to that observed in modern agriculture".

Schultz (1964) concedes that some institutional and cultural restraints, may have adverse effects on production. He insists that the subsistence producing unit therefore maximizes its production (subject to the constraints which are imposed by factor availabilities and production function), sells whatever is needed to obtain its necessary monetary income, and consumes the remainder. The marketed surplus thus varies inversely with market price of the subsistence crop of concern.

He also argues that the doctrine that farmers in poor countries either are indifferent or respond perversely to changes in prices is patently false and harmful (Schultz, ibid, p. 49). Since Schultz' proposition, a number of supply response studies have tended to support his hypothesis on small scale farmers. Among them are Dean (1966), Baterman (1965) and Ady (1968). Behrman (1968) and Askari et al (1976) also contain comprehensive reviews of such studies. These studies cover a wide range of commodities including annual crops such as maize, groundnut, sorghum and millet and perennial crops such as cocoa, rubber and sisal.

The second major hypothesis, also has a substantial number of advocates.

Neumark, (1959), Mathur and Ezekiel, (1961), Khatkhate (1962), all argue that subsistence farmers may have fixed or relatively fixed monetary obligations, and, therefore, only sell as much of their output as is necessary to obtain the required income. The relatively fixed need for money income may exist because of relatively fixed, monetary charges for rent, debt service and an inescapable small amounts of consumption of non-agricultural goods. Whatever production that need not be sold to obtain the desired monetary income has a very high utility at the margin in the on-farm consumption because of the inadequate food supplies which are available to the subsistence producers.

An alternative formulation which could underlie the same hypothesis of an inverse relationship between the marketed surplus of a subsistence crop and the market price is presented by Olson (1960) and Krishnan (1965). Olson and Krishnan both argue that an increased price of subsistence crop may increase the producer's real income sufficiently so that the income effect on demand for consumption of this crop outweighs the price effects on productior and consumption. The marketed surplus, therefore, may vary inversely with the market price.

The third major hypothesis, that cultural and institutional restraints make any price response of underdeveloped agriculture insignificant, is attributed to the theoretical underpinnings of Boeke's (1953) idea of "social dualism". Boeke maintains that the social systems which prevail in many developing countries are different from the social systems of economically more advanced countries not in degree, but in kind, and, thus, require economic theories which are different in kind from those which are applicable in developed countries. However, such restraints leave considerable leeway for responses to economic variables and that in the economic equilibrium of 'traditional agriculture' these responses result in efficient utilization of existing factors of production.

Most proponents of this third hypothesis, however, would not maintain that different economic theories are required to analyze underdeveloped agriculture. They contend, instead, that institutional and cultural constraints limit to relative insignificance the responses which are implied by generally accepted micro-economic theory. The subset of such constraint which is most often emphasized may be subsumed under what Wharton (1962) has termed "human inelasticity". Aspects of this inelasticity include limited knowledge of the "possible", limited tastes, limited inquisitiveness, a natural conservatism, and a set of social values which grant considerable prestige to the sponsors of certain social ceremonies and the holders of large amounts of factors, regardless of the efficiency with which such factors are utilized. A second subset of institutional restraints which has received considerable emphasis covers the various hypothesized market imperfections which prevent developing countries' agriculture from exhibiting significant price responses (Olson, 1960; Gupta and Majid, 1962;). The factor market is said to be imperfect in several important respects. Inadequate transportation, and communication facilities are hypothesized to have limited below desirable levels, supplies of factors such as chemical fertilizers in rural markets.

Even within small geographical areas, factor markets are said often to be very fragmented because of traditional tenure arrangement. Factors, thus, are not easily re-allocated as a result of price changes. Credit markets are said to be imperfect. Perhaps most important of all, knowledge of the new factor and new techniques is said to be considerably less than perfect. Product markets, too, are hypothesized to be far from perfect. Transportation and storage facilities are said to be inadequate. Markets are said to be fragmented in small geographical areas because of lack of a pervasive monetary system in combination with the overwhelming concern among many farmers producing enough food to guarantee physiological survival. In many localities, furthermore, farmers are said to be exploited by oligopolistic middlemen.

Various supporters of the institutional and cultural constraints hypothesis have weighted differently the importance of the various constraints. Support seems to be growing, however, for the analysis of developing countries agriculture as a system problem instead of emphasing only one or only a few constraints (Lewis, 1964). Interdependence, in this view, is considered pervasive that many determinants will have to be altered in concert if substantial output increases are to be achieved. Most members of this school of thought, incidentally would not exclude price as one determinant which should be appropriately varied but would only emphasize that price variations alone are liable to lead to a very limited response.

The supply response function is the basis for farmers' decision making with respect to output and supply. This is discussed below.

2.2: Farmers' supply response: survey of previous studies

The supply response function has been variously defined. According to Riston (1982), the supply response function is a functional relationship describing the way in which the quantity of a particular agricultural product offered for sale per unit time depends upon quantities of other variables operating under a given set of circumstances.

Prices are important determinants of economic behaviour. Most commonly, an increase in price will induce producers to increase supply of a commodity. In addition to price, there are several other factors which could affect the supply function of a commodity. Supply response studies thus try to pin-down the behaviour of supply when some of these other factors undergo change. Johnson (1950), defined the concept thus:

> *"The supply function for agricultural products is sometimes expressed as a simple relation between output and price of the output. However, the use of this relation obscures the complexity of the supply process determining the supply of agricultural products. The supply of agricultural products depends on (1) production conditions -the technological relation between inputs and outputs; (2) Supply conditions of the factors of production; (3) price and demand conditions for output; and (4) the behaviour of firms, including the objective of the entrepreneur".*

On their part, Learn and Cochrane (1961), defined supply response function as a linear relationship expressing quantity as a function of price and other variables. It is represented as:

$$Y = a + b_1 X_1 + b_2 X_2$$

where,

Y is the quantity, X_1 = price of inputs.

Learn and Cochrane (1961), further asserted that a shift in the supply function for an individual firm is characterized by a change in the planned level of output, for a given period, without any change in the decision making environment faced by the firm. To broaden the notion, Andah (1976) assumed that supply is a function of n variables and described by m parameters;

Supply = f (X_1, X_2 .... X_n, ά1 , ά2 ...m) ceteris paribus and described shifts and structural changes in the value of the above formulation as

"Shifts in the supply results from changes in the values of any of the variables, other than prices and quantity. Structural change, on the other hand, results from some forces which bring about a change in one or more of the parameters, or a change in the form of relationship. Structural changes are all important forces in supply consideration for agricultural products".

The supply response relation, though deceptively simple, is a complicated relationship, due to the large number of interacting factors in it. Empirical prediction of supply response is therefore a difficult task.

Elasticity, defined as the responsiveness of output and supply (dependent variable) to a small change in any of independent variables - according to Andah (1976) is usually used as a measure of supply response.

According to Quance and Tweeten (1972):

> *"Supply elasticities indicate the speed and magnitude of output adjustments in response to changes in product price or to other factors affecting output. The elasticity of supply for aggregrate farm output is essentially important because it measures the ability of the farming industry to adjust production to changing economic conditions continually confronting it in a dynamic economy".*

Supply response studies are therefore important at both the micro- and macro-levels of the economy.

A review of the literature on farmers' supply response reveals very wide range of studies with similiarly wide differences in results. In most of these studies, the efficacy of the price system in stimulating agricultural supply remains intact. However, the overbearing concern that once "prices are right", farmers will increase their output has prompted renewed interest in supply responses to price and non-price factors especially for developing countries (Ogbu and Gbetibouo

1990). There is conflicting evidence ranging from low price elasticity to lack of responsiveness depending on the country, crop and level of aggregation. This evidence is not new (see for instance Mathur and Ezekiel, 1961), but the growing literature on supply response on developing countries seems to suggest that, non price factors are more relevant in explaining agricultural supply (Lele, 1988; Lele et al., 1989, Smith, 1989; Lipton 1987; Binswanger et al., 1987). Various models have been used by different researchers to estimate agricultural supply response. Using the cross-sectional estimation model, Peterson (1988) attributed the low price elasticities obtained by researchers to the use of "conventional supply function fitted to time series data". He argued that time series estimates understate the true response to expected price changes, because much of the observed price variation is transitory, causing actual price to vary more than expected price. According to Peterson (1988), cross-country observations which reflect the response to differences in average level of expected prices results in more accurate estimates of long run supply elasticities. Other deficiencies of earlier models include incomplete accounting of input prices stemming from the use of only fertilizer price in calculating output/price ratio. Peterson obtained aggregate supply elasticity greater than 1.

Chhibber (1988) has criticized Peterson for assuming that only prices and the volume of research expenditure constitute constraints on agricultural supply response for developing countries. In fact, land constraints, availability of credit, ecological characteristics, legal status of production units etc have been identified as some of the constraints increasing price (Ogbu and Gbetibouo 1990). Binswanger (1985) attributed Peterson's high price elasticities almost exclusively to his choice of agriculture producer prices and identified the problem inherent in that choice. For instance, by replacing their price variables with Peterson's price variable, price elasticity of supply from Binswanger's model jumped from less than 0.2 to 1.53. There are other researchers (for instance, Griliches, 1960) who did cast doubt on their own results. Griliches obtained supply elasticity estimate as low as 0.15 but attributed this low elasticity to the use of conventional price indexes which do not capture all of the changes in relative prices. According to him, these changes are often attributed to trend and technological change (when this is represented by proxy).

Binswanger, Yang and Bowers (1987),- here- after referred to as BYB- used a sample of 58 countries for the period 1969-1987 to analyze and determine the role of price and non-price factors on agricultural supply. The cross-country analysis, according to this study, is useful in understanding the implications of choice of technology on supply response. The choice of techniques depends on public input as well as physical and human inputs. These determinants, according to Binswanger, Yang and Bowers (1987) are better understood in a sample that contains a wide spread of such variables. In their study, different variables were presented in the model. For instance, extension services were measured by the numbers of extension agents per capita of farm population, irrigation as percentage of agricultural land irrigated at least once a year, the physical infrastructure by road density and pavement-percentage of road paved; research by man years of research which was converted to stock of scientists, agroclimatic potential by potential dry matter production in each country etc. Several of these variables were normalized for country size by area of land which has a potential agricultural or forestry use.

The BYB model was estimated by a single equation technique but the large number of variables created the problem of multicollinearity. This problem was resolved by using the principal component technique suggested by Mundlak (1982) as cited by Ogbu and Gbetibouo (1990).

The ability and willingness of a producer to react to favourable price changes or improved technology according to Ogbu and Gbetibouo (1990), depends on his or her ability to export (in the case of export crops) as well as on land availability and farm-labour wage structure. For instance, in Malawi the war in Mozambique led to high transportation costs and export bottle-necks due to the closure of port outlets, and in Tanzania, the villagization increased population density and soil degradation. Contrary to the evidence provided by Boserup (1965) as cited by BYB, this high density had adverse effects on small holder tobacco and pyrethrum production (Lele, 1989).

A general criticism is provided by Chhibber (1988). According to him, cross-country estimation of supply function suffers from the problem of establishment of direction of causality. The assumption underlying the supply function is that prices influence output or productivity when, infact, it is possible to argue that high agricultural productivity which is associated with high per capita income may lead to higher price support for agriculture.

Cavallo and Mundlak (1982) use an intersectoral general equilibrium model to examine the effects of pricing and exchange policies on Argentine agriculture. Their study shows that long-run aggregate agricultural supply elasticity was 0.9 in Argentina. Using this model, they demonstrated that depressed prices lead to slow or retarded technological change in agriculture. This relationship assumes technological change is embodied in capital and capital is mobile, within and across sectors. In reality, however, capital is not that mobile (Ogbu and Gbetibouo, 1990). The structure of production in a country, according to Ogbu and Gbetibouo may be such that it limits the flexibility of producers to make a comprehensive decision. Commercial small holders in Malawi, for instance, cannot decide to produce crops that only estate holders are allowed to produce. They further argued, that it may even be more difficult to move capital into other sectors because of sunk-in costs, asset fixity, skills, etc. Experience from Nigeria, furthermore, has shown that improved prices alone cannot stimulate the adoption of technology. Land policies, crop production patterns, risks, and institutions are important factors in encouraging technological change in agriculture.

In a fairly recent study, Weaver (1989) used a microeconomic model of household choice to analyse supply response in Sub-Saharan African. This model reflected the fact that crop production in Sub-Sahara Africa is dominated by smallholders who allocate household labour across annual and perennial crops and in some cases, to wage labour market. This model was applied to Malawi.

However, in applying the model to Malawi, the author failed to distinguish between subsistence smallholders and commercial smallholders. This disaggregation, according to Ogbu and Gbetibouo (1990) is particularly important, since consumption, production and labour market decisions of these two classes of smallholders are different. Subsistence smallholders do not have profit maximizing behaviour. Again, since the responsiveness of commercial smallholders to prices or other incentives are greater than that of subsistence smallholders, the elasticities that will be obtained for the smallholder subsector will not reflect the true elasticities, and therefore, will carry very little information.

Akiyama and Trivedi (1987) analyzed perennial crop supply using a framework that allows for a distinction between the short run and the long run dimensions of the producer supply decisions while at the same time recognizing the role of technology and institutions. The short-run decisions are concerned with the utilization of factor inputs while the long-run decisions are concerned with the choice of technology and the level of new planting and replanting. Thus th. role of technology and institution are reflected in the investment decisions. Since technological progress reduces the marginal cost of new planting, one possible way of representing technology (according to Akiyama and Trivedi) will be to use the unit cost data. However, the use of unit cost data to represent technological change will only be appropriate in a strictly commercial setting where all costs are known including the cost of labour. In some subsistence smallholdings, the true costs of labour service provided by family members are often not known.

Most of the literature on supply response originating from sub-Saharan African sources usually deal with single commodity. Oni (1969) used simple linear models to analyze the production response of palm oil and palm kernel in Nigeria. The non-price factors included in the models were technology and a weather variable. The technological factor was represented by a time trend while PURVIS Weather Index was used as the weather variable. Oni's model included prevailing producer prices rather than lagged producer prices because oil palm producers are more concerned with the short-run production decisions. This position is supported by the fact that more than eighty percent of the production comes from the wild groves of oil palm. The results show that palm oil and palm kernel in Nigeria is price inelastic (0.34 for Palm oil and 0.22 for palm kernel). The weather variable was statistically insignificant in both results while the square of the trend was significant - only in the case of palm oil.

Adesimi (1970), also used a linear model to estimate supply elasticities for air-cured tobacco, in Western Nigeria. In addition to lagged prices of tobacco, the model included the price of yam, cassava, maize and a trend variable that represents changes in population of growers. The prices of other crops were included to reflect the likelihood that tobacco output decisions are expected to be influenced by the demand of the major food crops grown in the area. The results of the study revealed that the derived elasticity of acreage adjustment from the model was relatively high (0.73) indicating that a high proportion of the overall acreage supply adjustment in response to economic stimuli, takes place in the short run. The results also show a high price elasticity for substitute subsistence crops (-1.32 for yam). Thus one can infer that food crops effectively compete with air-cured tobacco for resources and that market factors affecting food crops will impact on the production of tobacco.

On the basis of the foregoing, the main factors affecting the market supply of an agricultural product can be symbolically represented as

$$Qs = f(T, P_p, P_{i..n}, I_{i..m}\ O, N, R, Z)$$

where:

Qs is the quantity of an agricultural product supplied to a market per time period.

T represents the production function of the product; sometimes referred to as the Technological Conditions of production.

P_p is the price of the product

$P_{1..n}$ are the prices of (n) other products.

$P_{i..m}$ are the prices of (m) inputs

O represents the objectives of the farm firm.

N is the number of farm firms supplying the market

R represents the size distribution of farms supplying the market, sometimes called the 'structure' of the agricultural industry.

Z - all other relevant factors such as

(I) Government policy eg Removal of Agricultural subsidy.

(ii) Natural events (like weather failure or an invasion of pests/diseases which destroy agricultural crops).

(iii) Export potential of the agricultural product

(iv) Farm labour wage structure

(v) Physical infrastructural development - eg. Roads, Storage facilities.

(vi) Availability of extension services

(vii) Research and volume of research expenditure

(viii) Land availability etc. etc.

It may be noted that each of the independent variables mentioned above may in turn be influenced by a number of factors.

The type of technology (T) used by farmers in their production activities, among others, has been shown by several researchers to be influenced by socio-economic characteristics of the farmers, characteristics of the farm, characteristics of the improved technology, available technological capacity of the economy to support the particular improved technology being promoted, government policy etc.

Basu (1969), in his study of the attributes of 108 randomly selected farmers in four villages in the Western State of Nigeria in relation to their level of adoption of recommended farm practices, found that farmers' farm size, extension, contacts, participation in organization, Land tenure status and occupation show significant relationship with adoption, while education, use of mass media, farming experience and socio economic status were not.

Falusi (1974), in his study of factors affecting chemical fertilizer adoption among farmers and the possible effects of different policy instruments designed to stimulate or encourage adoption in Western Nigeria, found out that the important variables that significantly influenced fertilizer adoption were, membership in co-operative or farmers associations, regular attendance at farmers meetings, availability of credit and frequent extension contact. However important socio-economic variables such as the number of demonstrations and trials in the districts, the availability of irrigation, and the use of other modern agricultural inputs did not sufficiently influence the adoption of fertilizer by the farmer.

Based on a sample size of 1,191 farmers in Ghana, Opare (1977) explored the relationship between adoption of recommended cocoa practices by farmers' and the correctness of their knowledge of principles underlying the practices, the farmers sources of cocoa husbandry information, and their personal and economic characteristics. Analysis of data obtained in this study revealed that literacy, farming experience, value of farm products, number of wives, advisory role played by farmer, correctness of knowledge of husbandry principles, and formality of information sources significantly influenced farmers' adoption. Age did not seem to play a significant factor in influencing farmer's adoption of cocoa innovations.

Other recent works that are consistent with the works of earlier researchers include the works of Ogunfiditimi (1981), Akinola and Young (1985), Hailu (1990), Polson and Spencer (1991), and Adesina and Zinnah (1993).

Central to decision-making but also an object of decision-making are the aims of a household with respect to the process and outcome of farming. Each household and each individual within it has specific felt needs and desires, but- judging from smallholders' action and statements reported in the literature, goals which have been found to frequently have high priority include profit maximization, cash maximization, subsistence security, flexibility and long-term economic stability (ie adequate and assured income to purchase required levels of material needs), a certain level of security reflecting farmers circumstance and psychology and observance of socio-economic, cultural customs and obligations and satisfaction of leisure (Clayton, 1983). These are briefly discussed below. It must be emphasized, however, that while these general categories can serve as a guideline for conceptualizing small-farm management and decision-making, their relative importance will vary among farming systems and only certain goals will pertain to specific strategies.

Profit maximization, according to Merrill-Sands (1986) can be operative as a goal in small farm agricultural systems or, more commonly, in components of them. Merrill-Sands (1986) further asserts that it is not realistic, to assume that profit mazimization is the sole or even primary goal of production. Norman et al., (1982) argued that the assumption that profit maximization is the primary goal governing management decision is only valid when the welfare of the farm family is maximized through profit maximization. This is rarely true in rural economics of developing countries.

More common than profit maximization in commercial strategies of small farms is cash maximization (Ewell and Merrill-Sands 1986; Merrill-Sands, 1984). In this case, the farm family strives to get the highest cash returns to cash invested and the value of labour and land invested are irrelevant. Cash often has a distorted value in rural economies because while it is necessary to obtain basic needs, or meet basic obligations, such as taxes or rent, it is scarce and the means available to the househod to obtain cash are often limited. This goal and the decision making it generates are not predicted by conventional economic analysis. It underlies the frequent observations by field investigators in rural economics that small farmers will stay in business when it is no longer profitable (Palerm, 1980; Warman, 1970).

Subsistence security is the most fundamental goal for small farm households for some small farms in more favourable environment, the risk of not meeting basic subsistence need is small, and thus, other goals become more important in decision making. But for the many small farm families operating in marginal conditions with limited resource endowments and relatively high risk in terms of yield variability and market fluctuations, it is the most critical goal (Ewell, 1984; Hill, 1982: Merrill-Sands, 1984; Scott, 1976, Reijntjes et al, 1992).

Several mechanisms are commonly used in small farm agriculture to assure that this goal is met. Small-scale farmers eschew full dependence on the market, which is often unreliable and exploitative of the small farmer who sells cheap and buys dear, by producing at least a major portion of their food needs. In rural economies, food is often not available when needed or, if it is available, it is priced significantly above the selling price. This is especially true during periods of scarcity as in the pre-harvest hunger period. This goal causes farmers to give food crops first priority in factor allocation decisions (Ewell and Merrill -Sands, 1986; Matlon, 1984).

A second common mechanism exploited to meet this goal is the maintenance of reciprocal social bonds with other households. In many rural societies, these bonds are ritually formalized and serve as a sources of social and economic security in times of crisis for a household assistance is expected and rightfully demanded. For households living close to margin of subsistence,

these bonds are of critical importance (Mayer, 1974; Norman et al, 1982).

The maintenance of social bonds can have a significant influence on production. First, they often provide a means of access to critical production inputs, such as land, labour, capital or water. Second, they often require goods which the household has to either produce or purchase with cash because they are maintained through practices such as giving gifts of food ,exchanging labour, ritual feasting and religious celebrations, or sharing of ritual obligations between households. Again, this goal would not be considered with common-sense assumption about economic behaviour and can not be adequately reflected in conventional economic analysis despite the fact that it can have major influence on production.

Implementation of practices which minimize risk is a third means by which small farm families strive to achieve the goal of subsistence security. For example, several strategies are exploited to avoid a catastrophic impact on households. If one fails, production or cash income of another can sustain the household at least on a short-term basis (Cornick, 1983; Merrill-Sands, 1984, Norman et al; 1982).

The goal of subsistence security and risk minimization can have a significant impact on technology transfer. Technologies which jeopaodize food production by competing for resource or factors of production are likely to be resisted unless the farm family is confident that they will be able to purchase food. Small-farm families may also reject an improved technology which increases variability in yields even if the mean yield is higher since they cannot afford to fall beneath the level of subsistence in any year (Matlon, 1984). Similarly, they may not adopt a technology which requires high inputs without stability of yields or which conflicts with practices employed to minimize risk such as mixed cropping. .

Flexibility is commonly found to structure the economic organization of small farm (Ewell, 1984; Merrill-Sands, 1984, Normal et al., 1982). Flexibility is attained primarily through diversification of strategies and crops and by maintaining multiple means of access to the critical factors of production.

The maintenance of flexibility protects the welfare of the household from the disruptive effects of instability in the physical, social and economic environment in which they are working. It allows them to respond to changing market conditions and re-allocate factors of production.

The goal of long-term economic stability of the household has an important effect on production decisions. It is most obviously manifested in parent-child relationship. Rules of inheritance, norms for old age case, dowry or bride-price requirements, all shape production decisions.

All of the goals aforementioned can be broadly categorized as economic goals. It should be stressed, however, that economic goals do not always determine behaviour. They may be secondary to even more fundamental goals reflecting cultural values and concepts which define what it means to be human or the relationship between human and nature. To this end, Reijntjes Coen et al 1992, mentions "Identity" as another important goal of the small farm household which affect decision-making. Identity, according to Reijntjes Coen et al (1992), refers to the extent to which the farm systems and the individual farming techniques harmonise with the local culture and the people's vision of their place within nature. It involves aspects such as personal preference, social status, cultural traditions, social norms and spiritual satisfaction. The smallholder farmers usually have a strong need to identify with the local culture. History and tradition play an important role in their lives and in their ways of farming. Changes that are incompatible with their social, cultural and spiritual values can elicit great stress and counterforces and are thus most likely to be rejected irrespective of other important benefits to be derived from them. Being able to gain a decent living befitting the local culture gives an individual or a farm family self respect. Self respect may also be derived from acting in solidarity and striving towards equality of all members of the community. A farm family's or community's feeling of identity is maintained by technologies that permit them to be self reliant and to control decision making about the use of local resources.

It may be deduced from the foregoing that traditional farmers have the capacity to respond appropriately to price and non price incentives

CHAPTER THREE

INTRODUCTION TO THE ANALYSIS OF SMALL SCALE MAIZE FARMERS' APPLICATION OF IMPROVED MAIZE PRODUCTION TECHNOLOGIES

3.0: Introduction

The present chapter provides an introduction to the analysis of small scale maize farmers' application of improved maize production technologies. The chapter is divided into two parts. The first part presents the profile of the study area and its influence on the small scale farmers' responses. The second part deals with the methodology. The methodology developed deals with two main issues. The first, essentially is an assessment of the major factors which influence the quantity of maize supplied by small scale maize farmers. The second issue, is the analysis of the major factors that determine the application of improved maize production technologies by small scale farmers in Ejura-Sekyedomasi District of Ghana.

3.1: Profile of the study area

3.1.1: Location and Size

The Ejura-Sekyedomasi district is one of the newly created administrative districts in the Ashanti Region. It was carved out of the old Sekyere and Offinso district council areas in 1989 as part of the decentralization process. It covers an area of about 1780km^2, approximately 7.3 per cent of the region's total land area. It is one of 18 districts in the region (Figure 3.1).

The district is located on the northern part of the region. It shares common borders in the north with Atebubu and Nkoranza districts of Brong Ahafo Region. It also shares boundaries in the east and west with the Sekyere West and Offinso districts respectively. About one-third of the district's total land area lies within the Afram Plains. Ejura is the district capital. Other main towns are Sekyedomasi, Anyinasu and Frante.

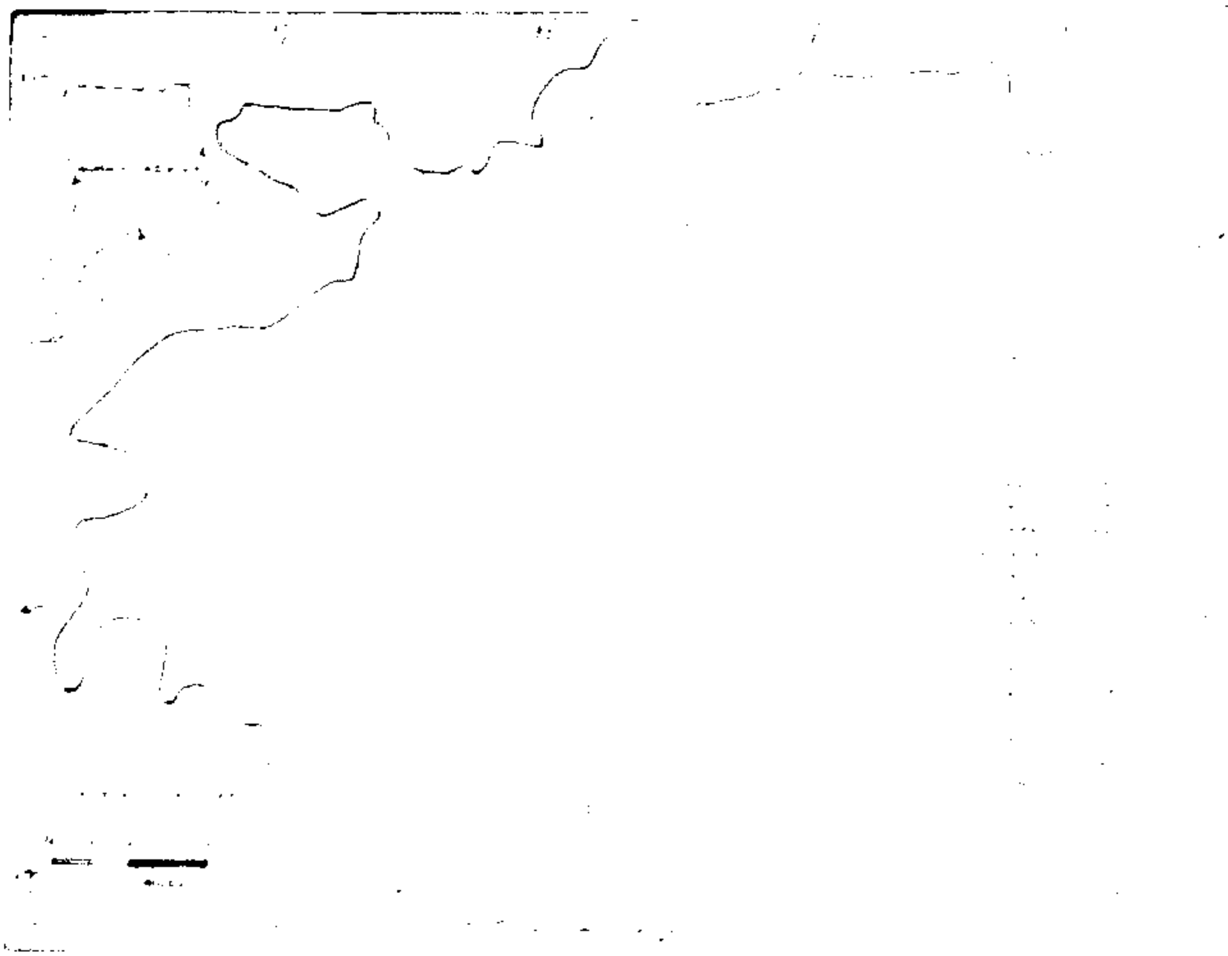

Fig 3.1

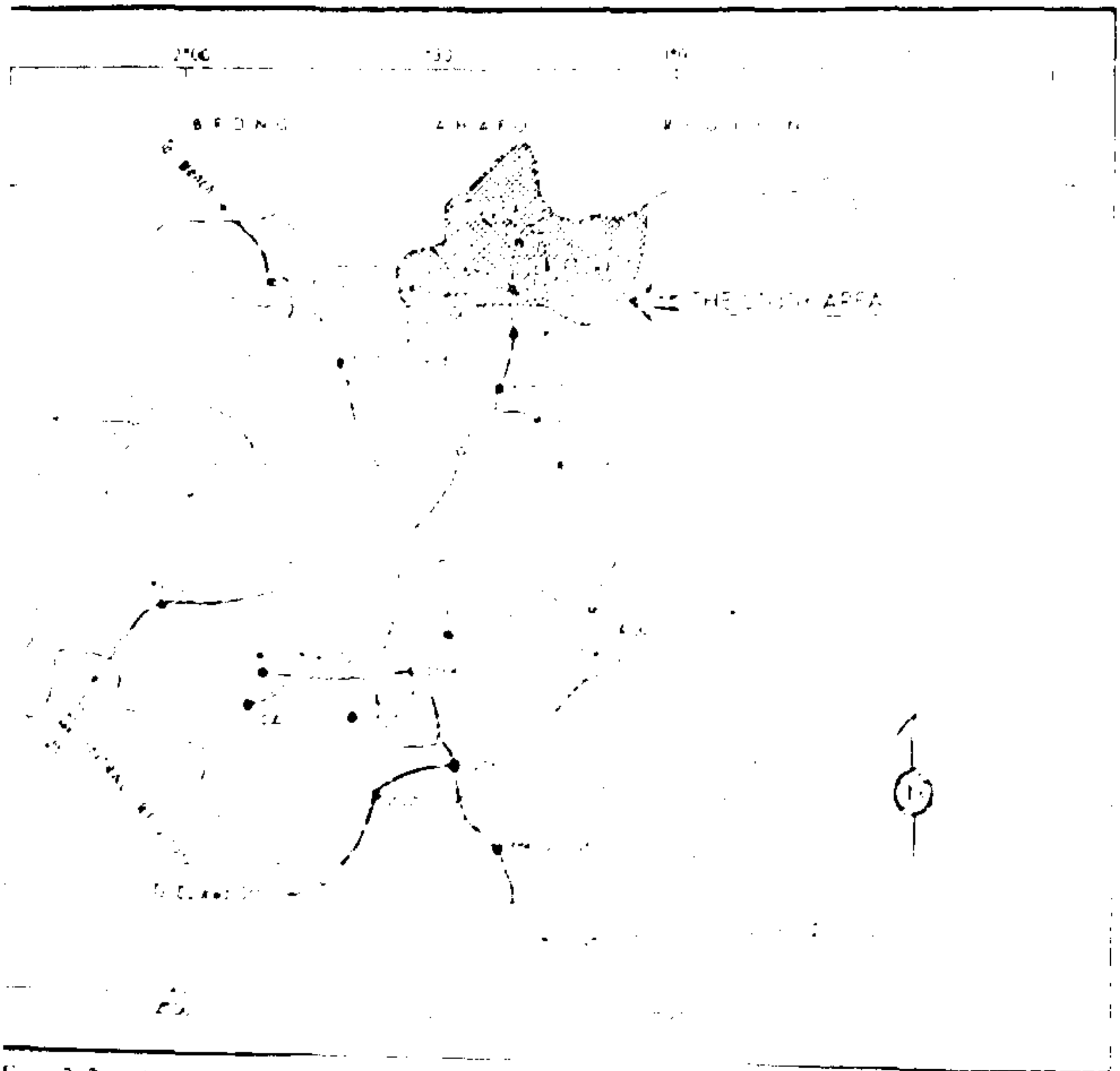

Fig. 3.2: Location of [illegible]

3.1.2.: Climate

Climate, vegetation, soils, topography and drainage and population density greatly influence the decision making of small scale farmers.

Climate, especially rainfall and temperature regimes loom large in decision marking of small scale farmers (Clayton, 1983). Rainfall, its amount, timing and seasonal distribution influences farmers's choice of crop enterprise, planting dates, type of technology adopted, labour use and so on. Generally farmers would select crops whose growth requirements are compatible with the prevailing climatic conditions. Drought resistant crops are generally grown in areas with smaller amounts of rainfal unevenly distributed while less drought resistant crops are grown in areas with reliable, and adequate amount of rainfall.

The district lies within the transitional zone, i.e. between the forest belt of the south and savanna in the north. Temperatures are relatively higher than in other parts of the region. The mean monthly temperature in the district is about 30 ℃ as compared to an average of between 25 - 28 °C for the region and between 25 - 35 ℃ throughout the year for the country.

The district experiences double rainfall maxima, i.e. two rainy seasons. The major season is between April and July. The minor season is between late September and November. The annual rainfall averages between 1200 - 1500 mm. There is a distinct dry season from November to April. Generally, the rainfall pattern is very erratic and unreliable. The existing climatic conditions are suitable for the cultivation of variety of crops. The most important crops grown in the area are yam, maize, cassava, cowpea, groundnut and vegetables (notably, garden eggs, tomato and okro).

3.1.3.: Vegetation, topography and drainage

The type of vegetation, topography and drainage also influence the type of farming systems practised in an area. For instance, mechanical land preparation is extremely difficult and expensive to undertake in forest area due the presence of large trees and thick vegetative cover. Again, hilly areas, sandy and clayey soils are also difficult to work on mechanically. Whilst in the case of the sandy soils mechanical land preparation results in further destruction of the soil structure, in the case of the clayey soils, because of its stickiness it makes it form big clods and difficult to work on. Again, continuous mechanical cultivation is believed to lead to destruction of soil structure and loss of protective vegetative cover and the benefits derived from them - organic matter, source of fuelwood and so on. Small scale farmers are aware of this and hence it is likely to influence their decision making.

As most part of the district lies within the transitional zone, it exhibits both forest and savanna vegetative characteristics. The vegetational zones are the semi-deciduous forest to the west (around Anyinasu) and the guinea savannah woodland to the north and east.

The guinea savannah consists generally of tall grasses interspersed with short, fire-resistant trees. The semi-deciduous zone represents a degenerated type of tropical forest. It is relatively denser in terms of tree cover and undergrowth. The original vegetative cover has degraded to secondary forest. Economic trees include odum, wawa and sapele as well as other lesser known species. Agriculture is the most significant land use in the district.

With respect to topography and drainage, the terrain is generally low-lying and undulating. The most significant relief is the range of hills running eastward through Ejura - Mampong. This range forms part of the main mountain range in the country i.e. the Koforidua-Kintampo range. The highest elevation is 600m above sea level.

The district is drained by several rivers. The most significant are the Afram, Akoba and Nyarde rivers. With the exception of river Afram, most of these other rivers are seasonal.

3.1.4: Soils

The soils in most parts of the district come under the Ejura-Amantin Association. These soils have been derived from weathering of Voltaian sandstone. On the flat summits and upper slopes of the gentle undulations are well-drained, red, deep, porous and permeable soils. In other parts the soil consists of slightly humus, loose porous structureless, sandy surface layers. The soils in the district are of high agricultural value. The structure of the soil, however, tends to be destroyed under continuous cultivation. The soil has the ability to retain moisture very well. Plant nutrient status is low to moderate and so is the organic matter content. The Ejura series is suitable for the cultivation of such crops as yams, maize, cassava, groundnut, tobacco, kenaf, millet, sorghum and soya bean.

3.1.5: Population

Population density of an area has important influences on decision making of small scale farmers, since it greatly influences access to land, use and maintenance of soil resources, the type of farming systems practised and the general standard of living. Growing population, for instance has been reported to cause high pressure on soil resources with serious consequences including soil erosion and falling standard of nutrition (Clayton, 1983).

The district has a population of 78,567 (Owusu-Bonsu and Asamoah, 1993) with an estimated annual growth rate of 3.1 per cent. Fifty-two per cent (52%) of the population are males and forty-eight per cent (48%) females. Forty-eight per cent (48%) of the population are children under 18 years old and fifty-two per cent (52%) adults (Tables 3.1 & 3.2).

The district has a population density of 44.1 km^{-2} as compared with 2992 km^{-2} for Kumasi, the regional capital (highest populated area per sq. km.) and 27 km^{-2} for Sekyere East (lowest populated per sq. km.). The average family size is 7. Natural increase and immigration are the main causes of the high population growth. The population is made up of several ethnic groups mostly from the Northern part of the country. The immigrants are mostly engaged in food-crop

1,000.

The first group of towns account for 55.2 per cent of total population of the district while the second and third groups account for 17.3 per cent and 5.7 per cent respectively. In addition to the three groups of towns the district has a total of 113 villages with population size below 500 (Owusu-Bonsu and Asamoah, 1993).

Table 3.3 Groups of settlement

Population Size	Towns	Percentage of District total Population (%)
Above 5000 but less than 30.000	Ejura, Sekyedomasi, Anyinasu	55.2
Above 1000 but less than 5000	Dromankoma, Aframso, Hiawuanwu, Frante, Kasei, Nkranpo, Bonyon, Drobon	17.3
Above 500 but less than 1000	Nyamebekyere, Sakoko, Miminasu, Juaho, Nkwanta, Bayere Nkwanta, Babaso	5.7
Below 500	113 Villages	21.8

Source: Owusu-Bonsu and Asamoah (1993).

3.1.7: Ethnicity

Access to productive resources especially land is greatly influenced by ethnicity. In most parts of Ghana, including the study area, land is communally owned and only members of the community or related clans have relatively easy access to such productive resource. Outright sale of land is not a very common practise in rural areas in Ghana. Ethnicity also influences the type of farming system practice.

One significant characteristic of the population in the district is its heterogeneity. A sizeable percentage of the population are migrants from Brong Ahafo and the Northern regions. Ashantis are the indigenous tribe. Settlements with very high migrant population include Ejura, Kasei and Hiawoanwu. There is harmonious co-existence among the various ethnic grouping in the communities.

3.1.8: Overview of agriculture

The main characteristics of the district's economy are similar to those of other districts in the region. As a rural district, farming is the single most important economic activity and it is estimated that over 70 per cent of the adult population are engaged in agricultural production.

The greatest asset of the district lies in its vast agricultural potential. It is estimated that about 80 per cent of the district's total land area can support crop production. With most part of the district lying within the transitional zone, a wide range of crops thrive in the district and the district forms part of the country's 'food basket'. A sizeable proportion of the land in the district is suitable for mechanized farming and the largest commercial farm in the country, Ejura Farms Limited is located in the district.

The main agricultural produce include maize, yams, beans, groundnut, tobacco, kenaf and vegetables. The district is a leading producer of maize and yams in the region. Cocoa is also produced in the western part of the district, particularly around Anyinasu and Bemi. Cocoa production is on the decline despite the efforts to revive its production after the 1983 bush fires. Marketing of food crops is an important economic activity. The district's economy is characterized by 'export orientation'.

The agricultural sector is dominated by small-scale peasant farmers whose production is basically rain-fed. Some form of mechanized farming is practised in most areas especially in the production of maize. The agricultural sector is characterized by under-employment as farming activities depend on erratic rainfall regime. Even though reliable production data and other quantitative information on yield are not readily available, it is generally conceded that the sector's performance is below average. Productivity is low and output of most farmers is well below average.

The poor performance in the agricultural sector is a major cause of low income and poverty among farmers. Farmers income most invariably depend on this output and price of the produce.

3.1.9. Road network

The main mode of transport in the district is road transport which is made up of trunk and feeder roads. The main trunk roads are the Aframso-Sekyedomasi road and the Ejura-Atebubu road.

Feeder roads form the bulk of the road network and it is estimated that the district has about 70km of feeder roads.

The main feeder roads include:-

1. Sekyedomasi - Anyinasu - Bemi road
2. Sekyedomasi - Drobon road
3. Sekyedomasi - Juaho road
4. Sekyedomasi - Nkoranza road
5. Ejura - Ebuom road
6. Ejura - Babaso - Oku road.

Most of the feeder roads are concentrated on the western part of the district with Sekyedomasi as the focus. From Sekyedomasi emanates two major feeder roads,

(a) Sekyedomasi ---> Nkoranza ---> Brong-Ahafo ---> Northern/Upper Regions of Ghana.

(b) Sekyedomasi ---> Aframso ---> Ejura-Techiman/Kumasi

which provides access to very important and major marketing centers in the country, i.e. Ejura Market, Techiman Market and the Kumasi Central Market. From Sekyedomasi, farmers in and around transport their farm produce notably maize, yam, cowpea through either Nkoranza to Techiman or through Aframso to Ejura or Kumasi for sale. Again, most of their farming and other non- agricultural goods are also sent to Sekyedomasi through the same route from where farmers in the surrounding towns and villages procure their needs during the major marketing day (i.e. every Thursday).

In addition these roads serve as the main linkage between towns and villages in the district with the district capital and other districts in the country.

Communities in the Afram Plains and the northern part of the district, west of Kasei lack access roads. Most of these areas are inaccessible. Tractors are the main means of transport. Farmers especially face a lot of difficulty in transporting their produce to markets.

3.2: Research methodology

Data used for this study were collected during a three-month field survey during the 1995 cropping season specifically, between July and September, 1995. The study was conducted in phases as follows:

3.2.1: Preliminary survey

This phase involved a two weeks long visit to the study area. This reconnaissance preliminary survey was for the purposes of collecting primary information for developing the survey questionnaire, finding out the feasibility of getting a good sample for the study and to book appointments for the main study. The preliminary survey also offered the researcher the opportunity to interact with the community to establish a good rapport. Farmers were interviewed during the preliminary survey regarding their current maize production technological practices, costs involved, quantity of product obtained, quantity of product sold, returns (money) obtained from products sold, source and regularity of inputs supply, marketing and other supporting capacities (infrastructure) available to assist in their maize production activities and their objective(s) of growing maize.

3.2.2: Selection of sampled village/town and households

This study focuses on maize production activities of small scale farmers in the Ejura-Sekyedomasi District. The target population for the study was thus all small scale maize farmers within the district. The Ejura-Sekyedomasi District was selected as the study area because it is located within the forest-savanna transitional zone. This zone is the major maize belt of Ghana and maize features as a major food crop in terms of production. The core of this maize belt is the Ejura-Techiman-Wenchi-Odumasi area. In this zone monocropping of maize is common and accounts for 60 per cent of the area cropped to maize (GGDP, 1991).

Furthermore, the study area is reputed to be one of major maize producing districts within the Ashanti Region and the country as a whole. Again, it is an area where various improved maize production technologies - improved seeds, fertilizer, post-harvest technology etc - had been introduced on large scale by both governmental (ie through the extension services department of the Ministry of Food and Agriculture) and non-governmental organisations such as S.G. 2000, World Vision International, etc.

A multi-stage sampling procedure was adopted. Listing of all the villages and towns classified into Group A (ie settlements with population above 5000 but less than 30,000), and Group B (settlement with population above 1000 but less than 5,000) in the district were prepared. From this list of villages and towns, a purposive sample of five villages/towns were selected. The villages/towns selected were EJURA, SEKYEDOMASI, ANYINASU, DROBON, AND FRANTE. The selection of the five towns and villages was based on the criteria that, (i) maize production is the principal agricultural activity in the town/village and (ii) the village/town satisfy the same or similar socio-economic conditions and be representative of the other villages/towns in the study area.

A list of all households in the selected villages/towns was compiled with the help of the Frontline Staff of Ministry of Food and Agriculture working in the area, the area's district assembly representatives and the district council office staff. From this list a specified number of households proportional to the population of the village/town was selected using the simple random procedure. Table 3.4 gives the number of respondents interviewed in each town/village.

Table 3.4 : Number of Respondents(Households) interviewed in each town/village

TOWN/VILLAGE	NO. OF HOUSEHOLDS
EJURA	45
SEKYEDOMASI	35
ANYINASU	16
FRANTE	10
DROBON	8
TOTAL	114

The willingness to co-operate with the researcher and his assistants, coupled with active involvement of household head in maize production activities were the main criteria for determining the sampling frame and the household head as the sample unit.

The respondents consisted of 114 farmers from 120 randomly selected maize farmers (95 per cent response rate). For the purpose of this study, a household was deemed to be composed of a number of persons that are directly related to one another by virtue of marital/filial bond and who have or indulge in:

(i) common abode be it detached, single house or compound house,

(ii) identifiable head of either sex

(iii) a common production enterprise

(iv) a common labour pool

(v) a common budget

(vi) a common consumption of what is produced

(vii) a common disposal of the surpluses of what is produced

(viii) a common utilization of the proceeds from the market sales of the surplus of what is produced

(ix) a common obligation to protect and ensure the safety and well being of each one of the members of the collectivity.

3.2.3: Design and administration of the research instrument

Three separate survey instruments directed at (i) Farmers (ii) Frontline Staff and (iii) Officers-in-charge of silos, respectively were developed, and content-validated for use in data collection (see Appendix **B**)

The research instrument for farmers included a pre-tested structured questionnaire containing eighty-one items designed around demographic/household information, farm and off-farm information, technology - specific information, technological capacity available, government policies, the objective(s) of farmers and so on. The questionnaire was administered to the selected farmers (ie household heads) by the researcher and a team of two trained interviewers who (i) had considerable knowledge about maize production activities and (ii) were conversant with techniques of interviewing local farmers in their local dialects and in their homes. The selected farmers were interviewed and their responses entered separately on the questionnaire forms. Informal discussions were also held with farmers to get more insight into their other agricultural operations.

Although the main focus of the study was maize farmers, agricultural front -line extension staff (FLS) in the study area whose work mandate covered maize (and other crops) were also included in the study in order to get their separate views on the improved maize production technologies being studied. The rationale for interviewing FLS was to enable the comparison of the responses given by the farmers with those given by the extension staff so as to determine how co-oriented these supposed intertwining groups are on the factors affecting the supply responsiveness and adoption of behaviour of small scale maize farmers.

Information solicited from the officers in-charge of silo was to enable the researcher appraise the technological capabilities available to promote the application or non-application of improved maize production technologies in the study area and the effect on the supply responsiveness of these farmers. Hence the inclusion of a questionnaire for the officers in charge.

Finally some of the relevant data were collected from secondary sources: These were:

(i) Climatic information (mainly rainfall data) for the Ejura-Sekyedomasi district collected from the Meteorological Services in Ejura.

(ii) Background information and area maps and land areas obtained from the District Planning Office also located at Ejura and

(iii) Price of maize in Ejura-Sekyedomasi District over the period

January to December, 1994 to August, 1995, obtained from the Credit and Marketing Service Division PPMED, Kumasi.

3.2.4: Data analysis: analytical framework and model specification

Data from the questionnaires were coded and entered into a microcomputer. Basic descriptive statistics comprising means, frequency distributions and percentages were obtained using SPSS/PC to examine the general trends in the data set . The adoption behaviour and the supply responsiveness of respondents(small scale maize farmers) were analyzed in sequence. First, the major factors influencing the decision making process with regards to the application of improved maize production technologies included in the study was analyzed. This was followed by the analysis of the supply responsiveness of the respondents to improved maize production technologies. To determine the importance of the major factors which influence the adoption decision of small scale maize farmers in the Ejura-Sekyedomasi District, the model

$$Tech = A_o + A_1 X_1 + A_2 X_2 + A_3 X_3 + A_4 X_4 + A_5 X_5 + U$$

was adopted.

Where Tech = Score on technology application by respondent.

X_1 = characteristics of small scale farmer (eg. age, farming experience, level of formal education family size, and membership of farmers' organizations).

X_2 = characteristics of the farm firm (eg.Farm size, yield/acre).

X_3 = Characteristics of the improved technology(eg.GM)

GM = Gross margin - a measure of the relative profitability was used as a proxy for the characteristics of the technology.

X_4 = Technological capacity of the economy (eg. extension contact, credit support sources of information and usage of available storage facility-silo).

X_5 = Effects of government policy used as a proxy for the prevailing economic environment.

Also, a step-wise multiple linear regression analysis was performed to assess the probability of farmers' supply responsiveness.

To assess farmers' supply responsiveness, the model stated below was used.

$$Qs = f(T, GM, O, R, R_t)$$

Where Qs = Quantity of maize supplied.

T = Technological condition of production/ Type of technology used

GM = Gross Margin - a measure of relative profitability and a proxy for P_p and $P_{i..m}$ (ie Price of product and prices of inputs i to m).

O represent the objective(s) of the farm firm (in this case the respondent farmers)

R represents the size distribution of the farm supplying the market (farm sizes used as proxy)

R_f = The annual rainfall in the area concerned.

The values for the various variables were obtained from the farmer responses. However, the values for technology, and objectives of the farm firm were weighted. The weighted value for the type of technology used was calculated in the following way: The frequencies of the three main types of improved maize production technologies included in the study were determined by scoring for each respondent. After tallying, the most frequently used technology - improved variety was given the highest score of 5, this was followed by chemical fertilizer application with a score of 3 and least used technology - tractor ploughing with a score of 1. On the basis of these scores, the total score for each respondent was determined. Thus, a farmer who uses a combination of improved variety, chemical fertilizer application and ploughing in his/her maize production activities was awarded a score of 5 + 3 + 1 = 9 and a farmer using improved variety plus ploughing a total score of 5 + 1 = 6 and so on. A similar procedure was used to determine the score for farmer objective for the individual respondents. The highest weight of 5 was scored for the frequently occurring Objective for producing maize - ie to earn income, followed by 4 for the reason "food for the family", 3 for "source of employment, 2 for food to feed the nation" and 1 for any other objective.

The gross margin for the individual respondent was obtained by subtracting the total variable cost incurred (ie cost of land preparation + cost of hired labour + cost of inputs (seeds and fertilizers) + cost of transportation and others) from the total revenue obtained from the farm of a known size.

The total revenue was calculated as follows:

Total revenue = total income obtained from sales of produce + the monetary value of products consumed, stored for future use or given out as gifts.

CHAPTER FOUR

SMALL SCALE FARMERS' APPLICATION OF IMPROVED TECHNOLOGIES: EMPIRICAL ANALYSIS

4.0 : Introduction

This chapter presents the major results of the study. The chapter sets the stage for the analysis of small scale farmers' application of improved maize production technologies. Data collected from 114 respondents are analyzed first, using the linear model hypothesized for the major factors which influence the adoption decision of small scale maize farmers. This is followed with the supply response model earlier hypothesized. The aim of the analysis was to achieve a parsimonious description of the underlying factors influencing the production behaviour of small scale maize farmers and their effects on the quantity of maize put on the market.

Section 4.1 which follows deals with data analysis and interpretation of the result.

4.1: Factors determining the application of improved technologies: empirical results

One of the objectives of the study was the indentification of the various improved maize production technologies that have been extended to farmers in the study area. Results of the study revealed that the planting of improved variety, application of chemical fertilizer, row planting, timely weed control, timely harvesting, post-havest treatment, proper spacing to attain optimum plant density and tractor ploughing were some of the improved maize production technologies that have been introduced into the study area.

A second objective of the study was to determine the levels and rates of applications of three improved maize production technologies, namely, planting of improved variety (I), application of chemical fertilizer (II) and tractor ploughing (III). The results are presented in Tables 4.1 and 4.2.

Table 4.1: Percentage Distribution of Respondents by Adoption Levels

Adoption level(s)	Percentage (n=114)
One technology only (i.e. I only, II only or III only)	20.2
Two technologies (i.e. combinations of I, II and III)	22.0
All three technologies (i.e. I + II + III)	57.8
TOTAL	100.0

Source: Survey Data (August, 1995).

As Table 4.1 reveals, majority of the respondents (about 58 per cent) applied combinations of all three technologies. The combination of proper land preparation (tractor ploughing), planting of improved variety and the application of chemical fertilizer has been reported to give high grain yield per unit area (Dowswell, Paliwal and Cantrell, 1996). Hence, the fact that the majority of the respondents applied all three technologies probably to maximize the benefits from the combined use of the improved technologies is not surprising but expected.

Table 4.2: Percentage Distribution of Respondents According to their Application and Non-Application of Improved Variety, Chemical Fertilizer and Tractor Ploughing

Application/ Non-Application	Improved Variety	Chemical Fertilizer	Tractor Ploughing
Application	97.4	76.4	64.1
Non Application	2.6	23.6	35.9
Total	100.0	100.0	100.0

Source: Survey Data (August, 1995).

With regards to adoption rates, as indicated in Table 4.2, planting of improved variety was the most commonly used technology. Comparatively, the cost involved in procuring improved variety compared to either purchasing chemical fertilizer or securing the services of tractor for ploughing is relatively cheaper. Again, the availability and access to improved maize variety as compared to chemical fertilizer or tractor service is also easier. For instance, whilst it is possible for small scale farmers to get improved seed maize from friends or family members living within the same locality, it may not be so for the other inputs. Thus, the observed trend in the adoption rates is also not surprising.

Farmers apply different choice and evaluation criteria to different technologies and the criteria employed vary among farmers depending on their household's goals for production and consumption and the resources and factors of production to which they have access.

Another objective of this study therefore was to analyze the decisions of small scale maize farmers in the Ejura-Sekyedomasi District about whether or not to apply improved maize production technologies, especically improved maize varieties, application of chemical fertilizer and tractor ploughing. In this section, the empirical results of the multiple linear regression analysis used for estimating the determinants of farmers' adoption of improved maize production technologies are presented.

To determine factors which influence technology adoption, the adoption level was regressed on the characteristics of small scale farmers (Xi), characteristics of the farm (X_2), characteristics of the technology (X), technological capacity of the economy to support the recommended technologies (X_4) and the prevailing government economic policies (X_5). For characteristics of the technology (X_3,) gross margin - a measure of relative profitability of using a particular technology- was used as a proxy. The results of the multiple linear regression analysis are presented in Table 4.3.

Table 4.3: Estimates of the Multiple linear regression model of the Farmers' Adoption of Improved Maize Production Technologies in the Ejura-Sekyedomasi District, 1995.

Explanatory Variables	Regression Co-efficients	Standard Deviation	T-ratio	Signif.T
X_1	0.01180	0.04309	0.27	0.785
X_2	0.2261	0.1279	1.77	0.080
X_3	-0.01106	0.06237	-0.18	0.860
X_4	0.91726	0.04558	0.38	0.706
X_5	0.19841*	0.08922	2.22*	0.028
Constant	3.0140	0.8998	3.35	0.001

* Co-efficient Significant at the 5% level.

Multiple Linear Regression Statistics

Multiple R	0.29325
R - Squared	0.08600
Adjusted R - Squared	0.04400
Standard Error	1.202

Analysis of variance

	df	ss	ms
Regression	5	14.671	2.934
Residual	108	156.066	1.445

F_{cal} = 2.03 Signif. F = 0.080

F_{tab} = 2.30 at the 5% level)

As Table 4.3 shows, only 8.6 per cent of the variation in the dependent variable is explained by the set of independent variables. Furthermore, the F calculated (2.03) compared to F tabulated (2.30 at the 5% level) was found to be insignificant. These pieces of evidence clearly indicate that the joint influence of independent variables (X_1, X_2, X_3, X_4 and X_5) are insignificant. In effect, the set of independent variables jointly do not influence the adoption decision of small scale farmers in the study area. However, only X_5 - the prevailing government economic policies - was found to be statistically significant at the 5 per cent level and therefore, perhaps the most significant predictor of farmers' adoption decision (T - value of 2.22 compared to the critical t-value ie t_{tab} of 1.98). This was found to be especially important for farmers in the study area, since at least 50 per cent of the respondents in the study area used improved maize varieties, chemical fertilizer, and tractor ploughing in their maize production operations. Again, the majority of respondents depended on hired services (tractor and labour) for their farming activities. The cost of using the improved maize production technologies included in this study was found to be greatly influenced by the prevailing government economic policies. For example, during informal discussion with the respondents, most of them claimed that the cost of hired labour, chemical fertilizers and charges for hiring tractor services for ploughing had increased by over 50 per cent during the 1994 and 1995 cropping seasons. This they attributed to government economic policies such as the removal of subsidies on agricultural inputs especially on chemical fertilizers, privatization and in most recent time to the implementation of the value added tax, which though was later repealed, still showed effects. Thus since over 50 per cent of the respondents utilize these improved maize production technologies, it meant increased cost of production to them. All this implies that the prevailing government economic policies are very significant in explaining farmers' application of improved maize production technologies.

Though, the characteristics of the small scale farmers (X_1), farm characteristics (X_2) and the technological capacity of the economy to support the recommended technologies (X_4) were positively related, none of them was found to be statistically significant in explaining farmers' adoption decision of improved maize production technologies included in this study. This result is consistent with the findings of Gerhart (1975), and Perrin and Winkelman (1976), who among others asserted that in multivariate analysis of large scale survey of adoption patterns carried out by international centers, no single farmers trait such as age, or education emerged as significantly correlated with adoption when in presence of other variables. Similarly, Zinnah (1992), also found and reported, that none of the farm and farmers' specific variables: age of household used, family size, participation in on-farm trials, farm size and extension visits, (though positively correlated to adoption decisions) were found to be significant in explaining farmers' adoption decision of improved mangrove rice varieties. Thus the past conclusions often reported in adoption and diffusion research about how farm and farmer characteristics are related to support for new or improved agricultural technologies were not supported in this study.

Given the generally low and non significant relationship obtained in this study for farmer specific-characteristics, farm characteristics, characteristics of the technology and the technological capacity of the economy variables in relation to predicting farmers application of improved maize production technologies, it seems that farmers' acceptance and/or rejection of improved maize production technologies is more dependent on the prevailing government economic policies.

4.2: Empirical results of supply response model

One of the fundamental objectives of the study was to analyze the supply responsiveness of small scale maize farmers in the Ejura-Sekyedomasi District. Specifically, the study sought to analyze how the application of improved maize production technologies influences the quantity of maize offered for sale (QS). However, it must be emphasized, that farmers responses are to a set of price and non-price factors taken in concert and not to the availability of improved technologies alone. Hence in this analysis, variables other than the availability of improved technologies are included.

It was hypothesized that the quantity of maize supplied (QS) was dependent on the:

(a) Technological condition (Type of technology) (T)

(b) Gross margin (GM)

(c) Farm size (size distribution of farm supplying the market). (R)

(d) Objectives of the farm family (O) and

(e) the annual rainfall of the area (R_t)

The model is specified as follows:

$$Qs = f(T, GM, O, R, R_r)$$

where:

Qs = Quantity of maize supplied

T = Technological condition of production/Type of Technology used.

GM = Gross Margin - a measure of relative profitability and a proxy for P_p and $P_{i..m}$ (Price of product and Price of Inputs i to m.)

O represents the objective(s) of the farm family (in this case the respondent farmers).

R represents the size distribution of the farm supplying the market (farm sizes used as proxy)

R_r the annual rainfall of the area concerned.

4.3: The correlation matrix

A useful starting point for the discussion is the correlation matrix fc - all the variables. The matrix shows the correlation between the dependent variable (QS) and each independent variable, as well as the correlation between and among the independent variables (T, GM, R, O, and R_r). The matrix highlights the importance of the variables selected, since the degree of correlation shows the levels of common variance.

Table 4.4 gives the correlation coefficients between pairs of variables. The values indicate both the direction of the relationship and the magnitude. The sign identifies the direction of the relationship. A negative correlation value indicates a negative or inverse relationship while a positive value indicates a positive or direct relationship. The closer the correlation value approaches either + 1.000 or - 1.000, the stronger or greater the magnitude of the relationship. On the other hand, the nearer the correlation coefficient value is to 0, the less the relationship and at 0, there is no correlation or relationship. In general, correlation coefficient between + 0.25 and - 0.25 indicate little or no correlation (Joseph and Joseph, 1980). Each row and column of the table represents one of the variables. In each cell of the table two numbers appear. The first is the value of the correlation co-efficient while the second in brackets represents the observed significance level. The rainfall variable was constant, therefore it was deleted from the analysis. As the table reveals, two variables (R) and (GM) are highly significant ($P<0.01$) and they substantially influence the supply while the variable T is statistically significant at $P = 0.05$. These coefficients are discussed first.

Table 4.4: Correlation Matrix for all Variables

	Quantity Supply QS	Technological Cond. T	Gross Margin GM	Farm Size R	Objectives of farmers O	Rainfall R_f
QS	1.000					
	.					
T	.172*	1.000				
	(.034)	.				
GM	.438**	.044	1.000			
	(.000)	(.321)	.			
R	.691**	.154	-.052	1.000		
	(.000)	(.052)	(.291)	.		
O	-.059	-.017	-.010	-.045	1.000	
	(.268)	(.430)	(.458)	(.318)	.	
R_f	.	.	.	.	.	1.000
	.000	.000	.000	.000	.000	.

*** - Coefficient Significant at the 5% level**

**** - Coefficient Significant at less than 1% level**

correlation coefficient obtained indicates that a direct positive relationship exists between supply (Qs,) and gross margin (GM). Thus all things being equal, an increase in GM is expected to encourage or stimulate small scale maize farmers to supply more to the market. However, even though a positive relationship exists, the relationship is not very strong. The observed strength of the relationship might be attributed to the "Cash maximization" objective of the small scale maize farmers. In this regard, the farm family generally strives to get the highest cash returns to enable them meet certain basic needs or basic obligations such as taxes, funeral donations, rent, etc. Profit maximization is not their major objective and hence value of land and labour invested are irrelevant. Thus once the cash requirement to meet their basic needs/obligations has been satisfied, other factors such as satisfactory amount of leisure, long term economic stability, observance of socio-cultural customs etc. become important. Hence as evidenced from this study, majority of the respondents (86.9 per cent) sold over 50 per cent of their 1994 harvested grain (Table 4.5), all in an effort to secure enough cash returns to meet their basic needs, and other social obligations.

Table 4.5: Percentage Distribution of Respondents by Fraction of 1994 Grain Harvest Sold

Fraction Sold	Percentage (n = 114)
Less than or Equal to 1/4	3.5
Less than or Equal to 1/2	9.6
Less than or Equal to 3/4	63.2
More than 3/4	16.7
All	7.0
Total	100.0

Source: Survey Data (August, 1995).

Though this finding is consistent with the findings of Tripp and Marfo (1991), it cannot be conclusively stated whether maize is a commercial crop or not within the study area.

Again, it can be argued that the relatively weak correlation betw .en the quantity offered for sale (Qs) and gross margin (GM) might be attributed to the generally low GM/acre obtained for the farms. Evidence from this study indicates that only 34 per cent of the respondents obtained gross margins/acre higher than the average GM/acre (¢40,000 - ¢59,999.00) (Table 4.6).

Table 4.6: Percentage Distribution of Farms by Gross Margin Per Acre.

Gross Margin/Acre (¢)	Percentage (n = 114)
Less than 1000	19.1
1,000 - 19,999	13.2
20,000 - 39,999	13.2
40,000 - 59,999	20.2
60,000 - 79,999	7.9
80,000 - 99,999	8.8
100,000 - 119,999	5.3
Equal to or More than 120,000	12.3
Total	100.0
Mean	¢40,000-59,999

Source: Survey Data (August, 1995).

Informal discussion with some of the respondents revealed that the average gross margin per acre was rather low, and that, the main reason why they continue to grow maize was that there was no other gainful job available and also to ensure availability of food for their families.

4.3.2: Supply versus Farm Size (Qs, R)

The correlation coefficient between the quantity of maize supplied (Qs) and farm size (R) is + 0.691, a fairly high positive correlation and is also as expected. Thus, the larger farm size the greater will be the level of output, as well as the quantity of output that would be put on the market.

Evidence from this study revealed that, land, though a crucial factor in agricultural development in general and maize production in particular, was not a critical limiting factor. For instance, 85.9 per cent of the respondents cultivated total land areas of between 2.0 acres and 19.99 acres (ie 0.8ha - 8ha) with the mean farm size of between 10.0 acre - 19.99 acres (Table 4.7), while nearly 76 per cent allocated more than 50 per cent of their total land area under cultivation to maize production with the mean size of maize farm being between 2.0 acres and 9.9 acres (0.8ha - 4.0ha) [Tables 4.8 and 4.9].

Table 4.7: Percentage Distribution of Respondents By Total Area Under Cultivation.

Total Area (Acres)	Percentage (n = 114)
Less than 2.0	1.8
2.0 - 9.99	41.2
10.0 - 19.99	44.7
20.0 - 29.99	7.4
Equal to or More than 30	4.4
Total	100.0
Mean	10.0 - 19.99 acres

Source: Survey Data (August, 1995).

Table 4.8: Percentage Distribution of Respondents by Percentage of Total Area Under Maize Cultivation.

Percentage of Total Area Under Maize	Percentage (n = 144)
Less than 20%	0.9
20.0 - 29.99	1.8
30.0 - 39.99	9.6
40.0 - 49.99	12.3
50.0 - 59.99	13.2
60.0 - 69.99	21.9
More than or equal to 70	40.4
Total	100.0

Tab l e 4 .9: Percentage Distribution of Respondents by Total Area Under Maize.

Total Area Under Maize (acres)	Percentage (n = 114)
Less than 2.0	5.3
2.0 - 9.99	71.0
10.0 - 19.99	19.3
20.0 - 29.99	1.8
Equal to or More than 30	2.6
Total	100.0
Mean	2.0-9.99 acres

Source for both tables: Survey Data (August, 1995).

Mechanical land preparation (ie tractor ploughing) allows for the cultivation of large farm sizes. Evidence from this study, however, revealed that only 7 per cent of the respondents (n = 114) own tractors (Table 4.10). Again, majority of the respondents (86 per cent) depended on hired tractor services for ploughing their maize fields. (Table 4.11). However, high cost of tractor services, lack of credit, and tractor services not being available on time, were among the major reasons adduced by some of the farmers for their failure to make use of hired tractor services during land preparation (Table 4.12).

Table 4.10: Percentage Distribution of Respondents by Tractor Ownership

Tractor Ownership	Percentage (n = 114)
Yes	7.0
No	89.5
Unspecified	3.5
Total	100.0

Source: Survey Data (August, 1995).

Table 4.11: Percentage Distribution of Respondents According to Source of Tractor for Ploughing.

Source	Percentage (n = 114)
Hiring	86.0
Use of Own Tractor	5.3
Friend/Relatives	0.9
Unspecified	7.8
Total	100.0

Source: Survey Data (August, 1995).

Concluding, it may be stated that though the positive correlation co-efficient (+ 0.691) is fairly high, the values could have been higher but for some bottlenecks observed during the field study. These are:

- Tractor services for land preparation not being available on time thus delaying the start of farming operations.
- Difficulty in getting hired labour during the peak periods of the farming seasons (ie. during weed control and harvesting).
- The inability of some of the farmers to buy and apply the recommended levels of inorganic fertilizer to their maize fields.

4.3.3: Supply versus Technological Conditions (Qs, T)

As expected the correlation coefficient (+ 0.172) between the quantity of maize supplied (Qs) and technological condition of production (T) was significant and positively correlated ($P = 0.05$). However, the correlation is very weak. This in part could be attributed to some of the reasons given by the farmer respondents, prominent among which were the high cost or expense involved in the use of these improved maize production technologies; lack of credit support to enable these small scale farmers buy and use improved inputs (eg. improved maize seeds, chemical fertilizer and so on) in their production activities; tractors services are not available on time, thus delaying the start of farming operations which indirectly could result in reduced yields and therefore lower quantities of maize offered for sale (Tables 4.12, 4.13, 4.14).

Table 4.12: Percentage Distribution of Respondents According to Reasons Mentioned for Not Using Tractor Ploughing.

Reasons for Non-Use	Percentage (n = 40)
Very Expensive	65.0
Lack of Credit	15.0
Service not Available on time	15.0
No real benefit	5.0
Total	100.0

Source: Survey Data (August, 1995)

Table 4.13: Percentage Distribution of Respondents According to Reasons Mentioned for Not Growing Improved Maize Varieties.

Reasons for Not Growing.....	Percentage (n = 3)
Seeds, Very expensive	33.3
Scarcity of seeds	33.3
Poor Storage quality	33.3
Total	100.0

Source: Survey Data (August, 1995).

Table 4.14: Percentage Distribution of Respondents According to Reasons for Not Applying Chemical Fertilizer, 1994 Cropping Season.

Reasons for Non-Application.	Percentage (n = 27)
Very Expensive	55.3
Lack of Credit Support	14.8
"Soil is Fertile"	18.6
Others	11.3
Total	100.0

Source: Survey Data (August, 1995).

The very weak relationship observed between supply (Qs) and technology (T) might also be attributed to the fact that these small scale farmers frequently associate a change in production technology with an increase in risk. These farmers have learned from past experiences that it is possible to subsist with their method of production they have used for many years. And as revealed by the analysis of data collected, as much as 77 per cent of the small scale maize farmers did not have ready access to credit facilities to support their maize production activities (Table 4.15 a & b). For that matter, they were probably not willing to risk the loss of the little wealth or cash they had to try out the improved maize production technologies at the optimum levels, and hence either continued to use their old proven production technologies or used the recommended improved production technolgies at levels below the optimum, resulting in the relatively very low yields (5-6 maxi bags/acre as compared to achievable yields 12-22 maxi bags/acre).

Table 4.15 (a): Percentage Distribution of Respondents by Availability of Financial Institutions Which Support Maize and Other Agricultural Production Activities

Availability of Financial Institution	Percentage (n = 114)
Yes	97.4
No	1.8
Unspecified	0.8
Total	100.0

Source: Survey Data (August, 1995).

Table 4.15 (b): Percentage Distribution of Respondents by Access to Credit Facilities.

Access to Credit Facility	Percentage (n = 111)
Yes	21.9
No	77.2
Unspecified	0.9
Total	100.0

Source: Survey Data (August, 1995).

The availability of technological capacity to support improved technologies being promoted is another major factor which influences the application of improved technologies and hence output and supply. Ready availability and accessiblility of supporting technological capacities such as efficient and effective extension services, improved storage facilities, motorable road network, and so on within an economy encourage application of improved technologies and hence stimulate increased output and supply. On the other hand, lack or inadequate and/or non-accessibility of supporting technological capacities discourages the application of improved technologies and the effect is lower output and supply. On the basis of the foregoing, it can be argued that the unexpectedly low correlation (+ 0.172) between supply (Qs) and Technology (T) might be due to the difficulty of respondents in getting the needed assistance from the existing supporting technological capacities and/or ignorance of the existence of such supporting capacities. Evidence adduced from this study indicates that majority of the respondents did not have any contact with extension agents. Supposedly, the latter are the main agents for disseminating information on the improved technologies and also assisting farmers to use these improved technologies correctly (Table 4.16).

Table 4.16: Percentage Distribution of Respondents by Extension Contact (1993 and 1994)

Extension Contact	Percentage (n=114) 1993	1994
Yes	44.7	43.0
No	54.4	56.1
Unspecified	0.9	0.9
Total	100.0	100.0

Source: Survey Data (August, 1995)

As Table 4.16 reveals in the 1993 cropping season, 54 per cent of the respondents reported of non-contact with any extension agent. This percentage increased to 56 per cent in 1994. The implication of this then, might be that, since most of the respondents did not have access to adequate and accurate information on the improved maize production technologies they might have continued to use their traditional, proven methods. The result was the lower output and supply obtained.

Again, evidence from this study indicated that even though majority of the respondents were aware of the existence of government-built improved maize storage facilities (silos), only a few stored their maize in them (Table 4.17).

Table 4.17: Percentage Distribution of Respondents by Availability and Usage/Non-use of Storage Facility(Silo)

Improved Storage Facility (Silo)	PERCENTAGE (n = 114) Yes	No	Unspecified	Total
Availability	78.9	21.1	0	100.0
Usage	4.4	77.2	18.4	100.0

Source: Survey Data (August, 1995)

The major reason given for the non use was lack of knowledge that small scale farmers could store their maize in the silo for a fee (Table 4.18).

Table 4.18: Percentage Distribution of Respondents According to Reasons Mentioned for Non-Use of Silo

Reason for Non-Use	Percentage (n = 88)
Lack of Knowledge	34.1
High Cost involved	28.4
Own storage facility adequate	20.5
Prohibitive Distance from from Production Unit to Silo	2.3
Others	14.7
Total	100.0

Source: Survey Data (August, 1995).

Most respondents were also aware of the potential benefit of increased crop yields that could be derived from the application of the improved maize production technologies included in this study (see Tables 4.19, 4.20, 4.21).

Table 4.19: Percentage Distribution of Respondents According to Most Important Reasons for Growing Improved Maize Varieties.

Most Important Reason	Percentage (n = 111)
Increased Crop Yield	50.9
Early Maturity	34.2
Increased Income	11.4
Availability of Technical Guidance	3.5
Total	100.0

Source: Survey Data (August, 1995).

Table 4.20: Percentage Distribution of Respondents According to the most important reason for applying chemical fertilizer.

Reason	Percentage (n = 87)
Increased Crop Yield	72.5
Increased Income	16.0
Availability of Technical Guidance	11.5
Total	100.0

Source: Survey Data (August, 1995).

Table 4.21: Percentage Distribution of Respondents According to Most Important Reasons For Tractor Ploughing.

Reason for Tractor ploughing.	Percentage (n = 74)
Increased Crop Yield	49.9
Make cultivation easier	27.0
Availability of Service/Equipment	12.3
Increased income	10.8
Total	100.0

Source: Survey Data (August, 1995).

The respondents were also conversant with the fact that increased maize yields if not properly stored could result in large storage losses and subsequent low financial returns. Finally, most small scale maize farmers do not have much problems handling yields obtained from applying their traditional maize production technologies. This is because, yields obtained are generally low and much of the product is either consumed by the farm household leaving little or in some cases none for storage or the product is stored for only short periods.

On the basis of the foregoing, it can be argued that most of the respondents either continued to use the traditional maize production technologies, the output of which they have been handling without much problems or might have applied the improved production technologies at below optimum or recommended levels to avoid or minimize the risks associated with the application of the improved maize production technologies. These risks include high storage and financial losses associated with storage of increased maize yields in local barns and high monetary investments in the improved production technologies. Hence the low output and low quantity supplied.

Another plausible factor that might have contributed to the low correlation between supply (Qs) and Technology (T) might be the effects of the prevailing government policies - Structural Adjustment Programme, Privatisation, and the Value Added Tax (VAT). When asked about their knowledge on the prevailing government policies aforementioned and the effects these policies had on their farming activities in general, and their maize production activities in particular, 96 per cent of the respondents claimed having knowledge of the policies and 90.8 per cent also intimated that these policies had negatively influenced their farming activities (Table 4.22 and Table 4.23).

Table 4.22: Percentage Distribution of Respondents by Knowledge of Government's Economic Policies

Knowledge of Gov't. Policies	Percentage (n = 114)
Yes	95.6
No	4.4
Total	100.0

Source: Survey Data (August, 1995).

Table 4.23: Percentage Distribution of Respondents by Influence of Government Economic Policies on Farming Activities

Influence of Gov't Policies on Farming Activities	Percentage (n = 109)
Yes	90.8
No	8.3
Unspecified	0.9
Total	100.0

Source: Survey Data (August, 1995).

Three major influences were mentioned by respondents as resulting from the implementation of these policies. Fifty three per cent of the respondents (n=88) whose farming activites were affected by the implementation of government economic policies said that the polices had resulted in high cost of farming inputs especially chemical fertilizers, improved maize seeds and other agro-chemicals while 33 per cent and 5 per cent of the respondents respectively mentioned high cost of hired labour and high transportation cost as the effects of the aforementioned government economic policies. Nine per cent of the respondents on their part gave other reasons, such as high cost of consumer goods, high cost of drugs and relatively high hospital bills, high cost of production, their inability to expand their farms, etc (Table 4.24).

Table 4.24: Percentage Distribution of Respondents According to The Effect of Government Economic Policies On Farming Activities

Effect of Policies	Percentage (n = 99)
High Cost of Inputs	52.5
High Cost of Hired Labour	33.3
High Cost of Transportation	5.1
Others	9.1
Total	100.0

Source: Survey Data (August, 1995).

During the field studies it was observed that most of the respondents were not able to adhere strictly to the recommended improved maize production technologies, hence the resultant low output and supply. Therefore, the observed correlation between supply (Qs) and technology (T) as evidenced in this study is not as expected but rather surprising.

4.3.4: Supply versus Objectives of farm family (Qs, O)

The correlation coefficient is - 0.059, indicating an inverse relationship between the quantity of maize supplied and the objective(s) of the farm family. The majority of respondents had more than one objective for cultivating maize.

The most important combination of objectives were to secure farm family food security and to earn income (Table 4.25). The inverse relationship thus obtained means that small scale maize farmers with multiple objectives are more likely to supply less maize to the market than farmers with single objective. This is not surprising since in an effort to satisfy all the objectives the farmer with multiple objectives is most likely to be less efficient in his farming operations than another farmer with just a single objective. For instance, in a bid to meet the dual objective of securing farm family food security and earn enough income, the small scale farmers might have cultivated large maize fields for which their limited resources (especially financial and labour) were not adequate to allow them carry out all the cultural practices efficiently. The effect was the low yields and hence low quantities supplied.

Table 4.25: Percentage Distribution of Respondents According to Reason Mentioned for Growing Maize

Reason(s) for Cultivating Maize	Percentage (n = 114)
Food for family only	3.5
To earn income only	5.3
Food for family+Income	83.4
Others*	7.8
Total	100.0

Source: Survey Data (August, 1995).

*Others include source of employment, food to feed the nation (Urban dwellers) and feed to feed poultry farmers.

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Food for family+Income	83.4
Others*	7.8
Total	100.0

Source: Survey Data (August, 1995).

*Others include source of employment, food to feed the nation (Urban dwellers) and feed to feed poultry farmers.

The negative relationship obtained could probably be attributed to the influence of some other objectives of the small scale farmers which antagonize increased production and hence increased quantity supplied (Qs).

The observed relationship between supply (Qs) and objective(s) (O) of small scale maize farmers in the study area could in part be attributed to the major objective of small scale farmers - subsistence security (ie an adequate and assured food supply and income to purchase required level of material needs). For some small farm families in more favourable environment, the risk of not meeting basic subsistence need is small and thus other goals become important. But, for many small families operating in marginal conditions with relatively high risk in terms of yield variability and market fluctuation, as it pertains in study area, subsistence security becomes the most critical goal. This goal is achieved through various mechanism such as the maintenance of reciprocal social bonds with other households. These reciprocal social bonds provide a means of access to critical production inputs (land, labour, capital etc). Second, these farmers often require goods which the household has either to produce or purchase with cash because they are maintained through practices such as giving gifts of food, ritual feasting and religious celebrations, or sharing of ritual obligations between households. However, this type of social obligations and bonds have been found to have a tremendous influence on supply of farm produce. For example, data collected in large-scale regional survey in Northern Nigeria in 1970-71 revealed that 18 to 20 per cent of total grain production was disposed off through gifts to other households (Norman et al, 1982). The amount of grain exchanged through non-commercial channels was roughly equivalent to that sold through commercial channels.

The desire of small scale farmers in study area to conform to social obligations such as attending funerals/special festivals could be another contributing factor to the observed relationship between (Qs) and objectives (O). Attending funerals, for example, takes these small scale farmers away from their farm work for some days and when these days occur during the critical periods (eg. active growth period of the maize crops), the plants become infested with weeds and in the end result in reduced yields. Subsequently the quantity that would be put on the market would also be low. Again, the days spent in attending funerals, also delays the implementation of certain important cultural practices (for example, the application of chemical fertilizers, weed control, harvesting and so on) and this also could result in reduced yield and quantity eventually put on the market.

Another plausible explanation for the observed relationship could be the desire of the farm family for satisfactory amount of leisure once their subsistence security is met. However, more leisure implies less work on the farm to increase output and subsequntly the low quantity supplied.

However, variables to measure the quantity of maize required to ensure an adequate and assured food supply for an average farm family, the desire of the small scale maize farmer to meet social obligations and customs, the influence of reciprocal social bonds and the desire of small scale farmers for some amount of satisfactory leisure were not included in this study and hence the observed relationship between Qs and O. There is therefore the need for further research into this area.

4.3.5: Gross Margin Vrs Technology (GM,T)

The correlation coefficient between gross margin (GM) and improved maize production technolgy (T) though positive as expected, was not statistically significant ($P \leq 0.05$). Analysis of the field data collected in this study revealed that irrespective of the technology used, outputs were generally low (Table 4.26).

Table 4.26: The Percentage Distribution of Respondents by Yield Per Acre for 1994 Cropping Season.

Yield/Acre (Bags)*	Percentage (n = 114)
Less than 1	0.9
1.0 - 2.99	16.7
3.0 - 4.99	30.7
5.0 - 6.99	32.5
7.0 - 8.99	14.8
Equal to or More than 9.00	4.4
Total	100.0
Mean	5.0 - 6.99 bags/acre

Source: Survey Data (August, 1995). *1 bag= 100 kg

As the table reveals, the mean yield per acre was between 5.0 and 6.99

bags/acre (500 kg - 699 kg/acre) compared to achievable yields of between 12 - 22 bags (1200 kg/acre - 2200 kg/ acre) reported by GGDP (1991). Erratic rainfall pattern, the difficulty in getting their land prepared on time due to small number of tractor hiring services and the high cost of inputs especially fertilizer which made it difficult for them to buy and apply the fertilizer at the recommended dosage were among the major reasons given for the low yields obtained.

The analysis also revealed that the costs of hired labour, land preparation and inputs were generally claimed to be high. The mean total variable cost per acre was between ¢60,000 - ¢89,999 (Table 4.27) while the mean gross income per acre was between ¢80,000 - ¢99,999 with the mode being more than or equal to ¢120,000 (Table 4.28)

Table 4.27: Percentage Distribution of Respondents by Cost Per Acre

Cost/Acre (¢)	Percentage (n = 114)
Less than 30,000	6.1
30,000 - 59,999	43.9
60,000 - 89,999	36.8
90,000 - 119,999	7.9
More than or equal to 120,000	5.3
Total	100.0
Mean	¢60,000-89,999

Table 4.28: Percentage Distribution of Respondents by Income per acre.

Income/Acre (¢)	Percentage (n = 114)
10,000 - 19,999	1.8
20,000 - 39,999	7.0
40,000 - 59,999	14.9
60,000 - 79,999	11.4
80,000 - 99,999	15.8
100,000 - 119,999	9.6
More than or equal to 120,000	39.5
Total	100.0
Mean	¢80,000-99,999

Source for both tables: Survey Data (August, 1995).

Further analysis of Tables 4.27 and 4.28 revealed that 87 per cent of the respondents incurred a cost of at most ¢89,999 while 65 per cent of the respondents obtained incomes greater than or equal to mean income per acre . Only 35 per cent of the respondents earned less than ¢80,000 per acre. Thus with high total variable costs and generally low output, the magnitude of the gross margin would be reduced. This thus reflects the low and non-significant relationship between gross margin and technology as evidenced in this study.

4.3.6: Farm Size versus Technology (R,T)

The correlation coefficient between farm size and technology (0.154), though positive as expected was also not statistically significant ($P < 0.05$). The low, non-statistically significant correlation coefficient obtained was unexpected. It was expected that with improved technology, for example, tractor ploughing, large areas could be farmed. But as revealed from analysis of field data, the number of small scale maize farmers who ploughed their maize fields were comparatively lower than those who applied the other improved maize production technologies included in the study (ref. Table 4.2). This could in part be attributed to the small number of small scale farmers who owned tractors, difficulty in getting access to tractor hiring services and possibly the very high cost involved in hiring tractor services, hence the observed trend.

4.3.7: Farm Size versus Gross Margin (R, GM)

The correlation coefficient is -0.052, and this was unexpected. It was expected that with large farm size, increased output would result and the quantity supplied to the market would correspondingly be large and high gross margins obtained. The observed trend, could be attributed to the fact that irrespective of farm size, average yield per acre was relatively low. Coupled with this was the observation that most farmers who farmed large areas could not apply the appropriate levels of chemical fertilizer to their farms to obtain increased yields. Again, their inability to get hired labour on time to control weeds on their farm, also greatly affected their yields adversely. Another reason for the negative relationship could be the relatively high total variable costs associated with large farms, which in most cases reduced the overall magnitude of gross margin.

4.4: Results of multiple linear regression analysis: The Supply Response Model

To establish the relationship between the dependent variable, quantity supplied (Qs) and the set of independent variables(T, GM, R, O, and R_J),a multiple linear regression analysis was used. The model used was based on the assumption that there is a normal distribution of the dependent variable(Qs) for every combination of the values of the independent variables. The result of the analysis is presented in Table 4.29.

Table 4.29: Estimates of the Multiple Linear Regression Model of Determinants of Small Scale Farmers' Supply Responsiveness to Improved Maize Production Technologies.

(Dependent Variable QS)

Explanatory Variables	B	SE B	BETA	T	Sig. T
T	.623459	.795787	.041489	.783	.4351
GM	2.02498E-04	2.2417E-05	.473308	9.033**	.0000
R	2.402516	.179863	.708284	13.358**	.0000
O	-.256565	.628778	-.021343	-.408	.6841
Constant	-.113673	8.475392			

** Coefficient significant at the 1% level

The regression equation is:

$$QS = -.113673 + .623459(T) + 2.02498E\text{-}04(GM) + 2.402516(R) - .256565(O)$$

Multiple linear regression statistics

Multiple R	.83975
R-square	.70518
Adjusted R-square	.69426
Standard Error	14.36826

Analysis of variance

	df	Sum of squares	Mean square
Regression	4	53330.80305	13332.70076
Residual	109	22296.26775	204.55291

F_{cal} = 65.17972 Signif F = .0000**

F_{tab} = 3.51

As the table shows, 70.5 per cent of the variation in the dependent variable is attributable to the influence of the set of the independent variables used. To test for the overall ability of the set of independent variables to explain the variation in the dependent variable (QS), the data was subjected to further tests (F-test and t-test). F-calculated (65.18) compared to F tabulated (3.51), was found to be highly significant ($P < 0.01$), implying the rejection of the null hypothesis and the conclusion that at least one of the set of the independent variables (T, GM, O, R) is useful in explaining the variation in Qs - the dependent variable.

As Table 4.29 futher shows, with the exception of the partial coefficient for the independent variable "O"(objectives) which is -0.2566,the rest- T, GM, and R had positive partial coefficients of 0.6235, 2.0250E-04, and 2.4025 respectively.

To find out which of the set of independent variables that significantly and substantially influence the quantity of maize supply by small scale farmers in the Ejura-Sekyedomasi District, a *t*-test statistic was performed. The result, revealed that gross margin (GM) and farm size (R) were the most significant predictors of the small scale maize farmers' responsiveness to improved maize production technologies. The t-values (calculated) for GM and R are 9.033 and 13.358 respectively compared to the critical t-values of 2.62 at 1% significant level. A regression computation was again run using only GM and R. The result is presented in Table 4.30 (a) & (b).

Table 4.30 (a): Multiple Linear Regression of significant variables (GM & R)
Dependent Variable =Qs

Explanatory variables	B	SE B	BETA	T	Sig. T
GM	2.03504E-04	2.2241E-05	.475176	9.150**	.0000
R	2.427700	2.078276	.714981	13.767**	.0000
Constant	2.140396	2.314602		.925	.3571

** Coefficient significant at the 1% level.

The regression equation:

$$Qs = 2.140 + 2.035E\text{-}04(GM) + 2.428(R).$$

Table 4.30 (b): Multiple Linear Regression Statistics of significant variables (GM & R)

Multiple R	.83752
R-squared	.70145
Adjusted R-squared	.69607
Standard Error	4.27676

Analysis of variance

	df	Sum of Squares	Mean Square
Regression	2	53156.27784	26578.13892
Residual	111	22624.68708	203.82601

F_{cal} = 130.39621 Signif F = .0000
F_{tab} = 4.82

As shown in Table 4.30(b), 70 per cent of the variance in Qs is explained by the two independent variables (GM and R) and the correlation co-efficient is highly positive (.83752). It is significant to note that a reduction of two independent variables caused a loss of only 0.4 percentage points in explained variation - a worthwhile trade because the new model, with only two independent variables would be easier to understand. In addition, in the revised regression model the two independent variables (GM and R) have significant partial regression coefficients ($P < 0.01$), [Table 4.30 (a)]. In sum then, it can be said that GM and R are the most significant predictors of small scale maize farmers' responsiveness to improved maize production technologies. t-values for GM and R are 9.250 and 13.767 respectively and the regression equation for the model is thus:

$$Qs = 2.140 + 2.035E\text{-}04\,(GM) + 2.428\,(R)$$

In this equation, 2.140 represents the regression estimate when both the gross margin (GM) and farm size (R) are zero. The coefficient of GM implies that supply (Qs) will increase by 2.035E-04, for each unit increase in gross margin (GM) if farm size (R) is unchanged. Similarly, the coefficient of R indicates that supply (Qs) will increase by 2.428 for each unit increase in farm size (R) if gross margin (GM) is held constant.

This evidence indicates that the relative profitability of the improved maize production technologies alone, is not a major determinant of supply of maize and as explained elsewhere, other objectives such as subsistence security, the desire to adhere or conform to social obligations and customs, satisfactory leisure and so on could be among the key determinants that could be manipulated to effect increased maize supply in the study area in particular and among small scale farmers in general. This evidence, also supports the fact that profit making is not the prime objective of small scale farmers as indicated elsewhere in this thesis.

CHAPTER FIVE
SUMMARY, CONCLUSION AND SUGGESTIONS FOR FURTHER RESEARCH

5.0: Introduction

In this final chapter, the findings of this study are summarized in section 5.1 and section 5.2 deals with the implications of the findings for policy. A final section, 5.3 discusses the implications of the study for further research.

5.1: Findings of the study

Three major findings emerged from the study.

First, planting of improved maize varieties is the most applied improved maize production technology in the study area.

Second, farm size (R) and gross margin (GM) are the major determinants of the quantity of maize supplied (Qs) by small scale farmer.

Finally, prevailing government economic policies determine the level of application of improved maize production technologies included in the study.

5.2: Implications for policy

Each of the findings of this study have a number of policy implications for programmes designed to increase farm output and quantity supplied (Qs). These are discussed below.

The study has shown that improved planting material (ie improved maize seeds) is the most applied of the various improved maize production technologies. Thus, any one wishing to promote increased maize output and hence the quantity supplied would need to encourage more small scale farmers to plant improved maize varieties. The strategy has implications for policy.

The first policy implication concerns the process of producing improved maize seeds which are compatible with the multiple objectives of small scale farmers. This implication falls within the realm of research and development. Such a policy should therefore provide the researchers especially plant breeders, and agronomists with the necessary logistics and motivation to encourage them produce the requisite improved planting material.

The second policy implication relates to the process of ensuring that improved seed maize are readily available at affordable prices and at the right place at the right time. Stated in more explicit terms, one is talking about improving the distribution/marketing efficiency of the improved seed maize. The policy should encourage small seed firms or private individuals to grow and/or sell improved seed varieties.

The third policy implication concerns the process of encouraging more small scale farmers to plant improved seed maize varieties. The policy should provide the requisite education and demonstration to raise the consciousness of the small scale maize farmers about the usefulness of planting improved varieties. This policy relates to the function of the Extension Services of the Ministry of Food and Agriculture. However, evidence from the study indicates a very weak linkage between extension staff and the small scale farmers. A number of recent studies (Compton, 1984, Synder, 1986, Merrill-Sands, 1989 and Kaimowitz, 1990 and Engel, 1990) have pointed out quite clearly that strong linkage between these groups are not merely a matter of efficiency, they are vital for successful technology development and delivery, particularly in developing countries such as Ghana. On the basis of the foregoing, there is thus the dire need to put in place policies that would encourage the development of stronger relationship between the extension staff and small scale farmers.

The study also revealed that both farm size (R) and gross margin (GM) were positively and significantly correlated to the quantity of maize supplied (Qs) by small scale farmers in the study area. This implies that anyone wishing to significantly enhance the quantity of maize supplied (Qs) would have to put in place strategies that allow small scale farmers to either cultivate more plots (ie improve on their farm size distribution), or allow for increased gross margins from farmers' maize growing activity, or both.

With respect to farm size (R), the first policy implication relates to ensuring that land is readily available and in sizes suitable for large farm or many farm plots. Such a policy calls for radical land reforms. Presently, there is no clear cut policy on agricultural land ownership by small scale farmers within the country. Lands are communally owned and are mainly controlled by chiefs or family heads.

This mode of land tenure has proved to be inefficient in the ability to satisfy the basic conditions for good land tenure arrangement. Some of these conditions are the ability to acquire good farm sizes, to hold title to land and have security of tenure. The specific features of the land tenure system which constitute barriers to the establishment of adequate size of farm are the fragmentation of holdings, the difficulty involved in acquiring new lands, the inability of farmers to make improvement, the absence of farm land registration, etc. A radical land reform policy that offers small scale farmers the opportunity to have easy access to adequate lands to establish good farm sizes, hold legal titles to the land on which they work and adequate security would significantly enhance their productivity and hence the quantity of maize that would be supplied (Qs).

This study also revealed that access to credit and tractor services for land preparation were also major constraints that limited farm size of small scale maize farmers in the study area. In this respect therefore, a policy that relates to making credit facilities readily available to serious-minded small scale maize farmers would be in the right direction. An additional desirable policy would be the establishment of plant pools within the major maize production areas. Previous experience with the concept of "plant pools" in Ghana failed. Lack of efficient supervision and improper record keeping were identified as the major causal factors for the failure. To overcome the problems that contributed to the failure of plant pools formerly established, an efficient supervisory team composed of small scale farmers, staff of Department of Agricultural Extension Services and Agricultural Engineering and

Mechanization Department, both of Ministry of Food and Agriculture, be formed in each location where a plant pool is established to effectively and efficiently oversee and monitor the running of the plant pool.

The study further indicated that gross margins obtained by respondent farmers were generally low. This among others were attriibuted to the generally low yields obtained from respondent farmers' maize fields and the high cost of hired labour. The policy implications of the foregoing are twofold:
First, a policy aimed at addressing the problem of lower yields resulting from declining soil fertility should be formulated and actively pursued. Since the study revealed that the lower yields obtained were due in part to the inability of the respondent farmers to buy and apply the recommended levels of chemical fertilizer because of its high cost, a desirable policy would be to encourage small scale maize farmers to use alternative method of maintaining the fertility of their maize fields. An example of such alternative method would be to encourage intercropping of maize with legumes. This policy has merit because in addition to the direct benefit of maintaining the soil fertility and increased yields, favourable climatic and edaphic condition exist in the study area for proper growth of maize-legume mixture.

A second desirable policy would be one that would help to reduce the cost of hired labour and hence reduce the total variable cost component. This calls for appropriate, well informed and conducive government economic policies.

Finally, the study revealed that the level of application of the improved maize production technologies included in the study is a function of government policy regime. This finding will find its usefulness in designing policies concerned with improving the levels of application of improved agricultural technologies.

In this regard, well-informed, appropriate and conducive government policies that concern the process of acquiring credit support by small scale farmers, improved infrastructural development especially road network and marketing channels for inputs and output and appropriate pricing for both inputs and output would be desirable.

In conclusion, it may be stated that the findings of this study are generally consistent with conclusions from studies by Lipton (1989), Richards (1985, 1986), Matlon and Spencer (1984) and Matlon et al., (1984) which indicate that the poor performance of agriculture in Sub-Saharan Africa may in part be due to deep ignorance, particularly on the part of researchers, surrounding small-holder food farming especially in the humid and semi-humid areas of Africa. On the basis of the above, there is the need for conscious effort to be made by researchers (as well as research administrators and agricultural policy makers) in thoroughly understanding smallholder food farmers and the conditions under which they produce. This means that agricultural innovation should be developed and recommended to small scale farmers not only on the basis of their agronomic soundness but also on the basis of the prevailing government economic policies and its influence on the production activities of small scale farmers.

5.3: Suggestions for further research

Some particular findings of the study are highlighted here with a view to generating further research. First, the finding that the objective(s) of small scale farmers did not significantly influence the quantity of maize supplied (QS) need further researching. A vigorous research into this variable and others such as the socio-cultural environment, family size, education, income and resource endowment, would greatly contribute to a clearer understanding of small scale maize farmers' application of improved technologies.

A second finding, is the extreme importance of prevailing government economic policies on the adoption behaviour of small scale maize farmers. A further research to evaluate the effects of these policies on the supply response of small scale farmers and agricultural performance in general would provide adequate information to substantially help agricultural policy makers formulate appropriate policies that would make the small scale farmer more productive.

The findings of this study suggest that in order to increase the quantity of maize to be supplied by small scale farmers, first, government needs to create a conducive environment that would allow farmers to, among other things, have access to a range of cost-effective agricultural inputs and services. Secondly, government should provide steady and adequate funding for research and extension programmes and more importantly government agricultural policy should set research targets that are not limited only to yield increases but also to other traits such as good storage characteristics and also mobilize the appropriate financial and human resources to achieve specific research needs.

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APPENDIX A

RECOMMENDED IMPROVED MAIZE PRODUCTION TECHNOLOGIES

Table 1.1: Characteristics of Commercial Maize Varieties Released by Crop Research Institute (CRI)

Variety	Grain Colour	Plant Texture	Height (cm)	Days to: 50% Silk	Maturity	Avg. Ton/ Ha	Yield Bags Acre
Dobidi	White	dent	205	60	120	5.5	22
Okomasa**	White	dent	198	59	120	5.5	22
Golden-Crystal	Yellow	dent/ flint	200	55	110	4.6	18
Obatanpa**	White	dent	175	55	105	4.6	18
Abeleehi**	White	dent	157	53	105	4.6	18
Aburotia	White	dent	150	51	105	4.6	18
Dorke SR**	White	dent	165	46	95	3.8	15
Safita-2	White	dent	165	47	95	3.8	15
Kawanzie	Yellow	flint	160	46	95	3.5	14

* Agronomic data are averages from station variety trials conducted at eight locations in Ghana.

** Streak resistant

Table 1.2: Recommended Planting Calenders for the Major Agro-Ecological Zones

Location	Planting	Recommended Early Planting	Variety Late Planting
MAJOR SEASON			
Forest	Early Mid-End of April	Okomasa, Dobidi, Obatanpa	Obatanpa, Abeleehi
Transition Zone	Mid Mar-End of April	Okomasa, Dobidi	Obatanpa, Abeleehi
Coastal Savannah	End of Mar-End of April	Okomasa, Dobidi	Obatanpa, Abeleehi or Dorke SR
Guinea Savannah	End of May-End of June	Okomasa, Dobidi Obatanpa	Obatanpa, Abeleehi Kawanzie or Dorke SR
MINOR SEASON			
Forest Zone	Mid July-Early September	Okomasa, Dobidi Obatanpa	Dorke SR, Obatanpa or Abeleehi
Transition Zone	Mid July-Early September	Okomasa, Dobidi Obatanpa	Obatanpa, Abeleehi or Dorke SR
Coastal Savannah	PLANTING NOT RECOMMENDED		

Table 1.3: Recommended Plant Spacings for Maize

	OKOMASA, DOBIDI, GOLDEN CRYSTAL	OBATANPA, ABELEEHI, ABUROTIA, SAFITA-2, KAWANZIE,
SPACING		
Between row:	90 cm	80 cm
Within row:	40 cm	40 cm
POPULATION*	56,000 plants/ha	62,500 plants/ha

* Expected population when two seeds per hill are planted

Table 1.4: Fertilizer Guideliness For Maize

		STARTER FERTILIZER (20:20:0)		SIDEDRESS (Amm. Sulphate) APPLY 4-5 WAP**	
AGRO-ECOLOGY	CROPPING HISTORY	BAGS/ ACRE	PLANTS/* MILK TIN	BAGS/ ACRE	PLANTS/ MILK TIN
Forest	land fallowed for at least 5 years	NO FERTILIZER RECOMMENDED			
Forest	land cropped the previous year or cleared after less than 5 years fallow	1	60 (68)	1	60 (68)
Transition	land fallowed for at least 5 years	NO FERTILIZER RECOMMENDED			
Transition	land cropped the previous year or cleared after less than 5 years fallow	1	60 (68)	1	60 (68)
Transition	continuously cropped	2	30 (34)	1	60 (68)
Savannah	land fallowed	1	60 (68)	1	60 (68)
Savannah	continuously cropped	2	30 (34)	2	30 (34)

* Plants per milk tin refers to the number of maize plants (not hills) that can be fertilized, if recommended plant populations are adopted. The first number is for full season varieties such as Dobidi planted in 90 cm rows. The number in parenthesis is for early maturing varieties planted in 80 cm rows.

** Weeks after planting

NB 1 bag per acre of 20:20:0 fertilizer + 1 bag per acre ammonium sulphate is equivalent to 51N:25P:OK kg. per hectare. 1 bag per acre of 15:15:15: fertilizer + 1 bag ammonium sulphate is equivalent to 45:19:19 kg of N:P:K kg per ha.

APPENDIX B

QUESTIONNAIRE

SMALL SCALE MAIZE FARMERS AND APPLICATION OF IMPROVED AGRICULTURAL TECHNOLOGIES: A CASE STUDY OF EJURA-SEKYEDOMASI DISTRICT OF GHANA

QUESTIONNAIRE FOR FARMERS

Interviewer's Name: .... Date: ....

Name of Village/town: .... Village Code:.....

Name of Household head: ....

Gender of household head: (Please Tick)

1. Male [ ] 2. Female [ ]

Age of household head: (Please Tick)

1. Below19 years [ ]
2. 20 - 29 years [ ]
3. 30 - 39 years [ ]
4. 40 - 49 years [ ]
5. 50 - 59 years [ ]
6. 60 - 69 years [ ]
7. Over 69 years [ ]

I. Characteristics of the Small Scale Farmer.

1. How many persons currently are in your household?
....

2. **Please tell me the structure of your household**

No of: Children	0 -10 yrs	11- 20 yrs	21 -30 yrs	31-40 yrs	41 - 50 yrs	51+ yrs
Adult: Active Male Active Female						

3. What is your marital status ? (Please tick)
   1. Single [ ]
   2. Married [ ]
   3. Divorced [ ]
   4. Widowed [ ]
4. If married, how many wives do you have?
   1. One wife [ ]
   2. Two wives [ ]
   3. More than two wives [ ]
5. Did you have any formal schooling?

   1. Yes [ ] 2. No. [ ]
6. If yes, what level of formal education do you have?
   1. Primary Education (1-10 years of school education) [ ]
   2. Secondary [ ]
   3. Vocational /commercial [ ]
   4. Technical [ ]
   5. Teacher training [ ]
   6. Polytechnic [ ]
   7. University [ ]
   8. Others (Please specify) ....

7. How many years have you been farming on your own (that is cultivatin your own farm)?

....

8. How many years have you been cultivating your own maize farm?

....

9. Do you belong to a farmer's organisation?

1. Yes [ ] 2. No [ ]

10. Name of organisation if answer to Question 9 is yes

....

11. Have you participated in any of the following programmes? (Please tick)

PROGRAMME	AVAILABLE TO FARMERS		PARTICIPATED PROGRAMME		USEFUL TO YOUR FARMING ACTIVITII			
	YES	NO	YES	NO	VERY USEFUL	USEFUL	NOT USEFUL	DON'T KNOW
Farmers' Training Programme								
On-Farm trial								
Field Days/fairs								
Demonstration								
Farmer's Day								

12. What is your ethnic grouping?

....

13. How are decisions made within the household?

1. Male head, Sole decision-maker [ ]

2. Decision-making shared among adults [ ]

3. No clear cut decision making procedure [ ]

4. Others (Described)

....

....

II. CHARACTERISTICS OF THE FARM.

14. Please tell me the various crops that you cultivate

....

....

....

15. How many fields did you cultivate last year (1994) both Major and Minor Seasons?

MAJOR				MINOR			
Field No.	Size (acres/ hectares	Crops Grown	Land* Prepar-ation method	Field No.	Size (acres/ hectares	Crops Grown	Land * Prep-arat-ion Method
1.							
2.							
3.							
4. 5.							

1 = Tractor ploughing

2 = Manual (use of hoes/cutlass etc.)

3 = Others (please specify) ....

16. Number of fields planted to maize in 1994 (refer to Question 15)

....

17. How did you obtain the land? (Please tick)

FIEL D NO	LAND INHERITED	LAND RENTED	LAND PURCHASED	LAND AS A GIFT	OTHERS (PLEASE SPECIFY)
1					
2					
3					
4 5					

18. Please tell me the purchase price or rent for those fields purchased rented?

FIELD	PURCHASE PRICE	RENT

19. Rank the crops you grow according to the order of importance and indicate whether it is for home comsumption or cash.

CROP	RANK	HOME CONS.	CASH
1.			
2.			
3.			
4.			

20. For each crop that you cultivated, give information on the quantity harvested (1994) (or expected to harvest this season (1995)

CROP(S)	QUANTITY HARVESTED OR EXPECTED TO BE HARVESTED	UNIT OF MEASURE	PERIOD

22. Of the maize grain harvested in 1994:
a. What fraction was sold?

i. All [ ]
ii. Less than or equal to 1/4 [ ]
iii. Less than or equal to 1/2 [ ]
iv. Less than or equal to 3/4 [ ]
v. More than 3/4 [ ]
vi. None [ ]

b. What fraction was consumed by the household?

i. All [ ]
ii. Less than or equal to 1/4 [ ]
iii. Less than or equal to 1/2 [ ]
iv. Less than or equal to 3/4 [ ]
iv. More than 3/4 [ ]
vi. None [ ]

c. What fraction was stored for future use?
i. Less or equal to 1/3 [ ]
ii. Less or equal to 1/2 [ ]
iii. Less or equal to 3/4 [ ]
iv. More than 3/4 [ ]

23. Please indicate the market price for the various produce sold.

CROP	QUANTITY SOLD	PRICE PER UNIT	PERIOD (MONTH/YEAR)	TOTAL

24. Please indicate the amount of cash expenses you incurred in the production of the crops you cultivated on your fields (indicate your expenses by the type of operation performed.

24a

CROP ¢	LAND PREPARATION ¢	SEED/ PLANTING MATERIAL ¢	FETERLIZER ¢	HIRED LABOUR ¢	TRANSPORTATION ¢	OTHERS (SPECIFY) ¢

24 b.

CROP	HIRED LABOUR FOR							
	LAND PREPARATION ¢	PLANTING ¢	FERTILIZER APPLICATION ¢	WEEDING/ WEED CONTROL ¢	PESTICIDE APPLICATION ¢	HARVESTING ¢	DEHUSKING MILLING BAGING	OTHERS

NB: Transport cost should include:

i. Cost of carting inputs to farm

ii. Cost of carting output from farm to home or consumption centers (market)

25. With respect to the following maize production activities listed below please indicate the activities performed by different household members by gender and the approximate number of days it took to complete each activity.

NUMBER OF DAYS WORKED ON/BY:

ACTIVITY	NUMBER OF DAYS TO COMPLETE	MEN	WOMEN	CHILDREN
Land Clearing				
Planting				
Weed Control				
Fertilizer application				
Harvesting				
Storage				

26. Did you borrow any money to help in your maize farming last year?

1. Yes [ ] 2. [ ]

27. If yes to question 26, give the main source of the money borrowed (Please tick)

1. Bank [ ]
2. Money Lender [ ]
3. Personal Savings [ ]
4. Cooperative [ ]
5. Family members [ ]
6. Others (specify) ....

28. Please tell me the reason(s) for borrowing?

....

....

29. How soon after harvest do you normally sell most of the maize harvested in

a. the major season ....

b. the minor season ....

(* Please state the month of the year)

30.a Where do you normally store your maize after harvest?

1. Home

2. Farm

3. Others (Please specify)

b. How do you store your maize after harvest?

1. Barns/room with husk [ ]

2. In barns/room without the husk [ ]

3. In bags, shelled [ ]

4. In cribs with husks [ ]

5. In cribs without husks [ ]

6. Others (specify) ....

30 c. Do you apply anything to the stored maize?

1. Yes [ ] 2. No [ ]

d. If 'Yes"

i. What do you apply?

....

....

ii. How do you apply it?

....

....

e. What are the major problems associated with your current storage practice of maize?

1. ....

2. ....

3. ....

III. APPLICATION OF IMPROVED PRODUCTION TECHNOLOGIES

31. Have you heard of any of the improved maize production technologies?

Yes [ ] No [ ]

32. If yes to question 1, Please List the type(s) of technologies

1. ....
2. ....
3. ....
4. ....
5. ....

33. Have you used any of the improved maize production technologies you have mentioned?

Yes [ ] No [ ]

34. If yes to Question 33, which of the following improved maize production technologies do you currently use?

1. Ploughing only
2. Application of chemical fertilizer only
3. Planting of improved maize variety only
4. A combination of ploughing and application of chemical fertilizer.
5. A combination of ploughing and planting of improved variety

6. A combination of planting of improved maize variety and the application of fertilizer.
7. A combination of ploughing, planting of improved maize variety and the application of chemical fertilizer
8. Others (specify) ....

35. If No, give details of your current, maize production practice

Land preparation: ....

Planting Material: ....

Method of maintaining of improving soil fertility

....

III. B. PLANTING OF IMPROVED VARIETIES

36. Have you ever seen any 'agric maize"?

1. Yes [ ] 2. No [ ]

37. Have you ever grown any "agric maize"?

1. Yes [ ] 2. No [ ]

38. If yes to Question 37, most recent year the crop was grown

.... and variety grown ....

1. Dobidi 2. Okomasa
3. Obatanpa 4. Abeleehi
5. Aburotia 6. Golden Crystal
7. Dorke SR 8. Safita 2
9. Kwanzie 10. Others (Specify)

39. Do you still use the "agric maize" on your farm?

1. Yes [ ] 2. No

40. What are your reasons for using the "agric maize"?

Reasons	Rank	
1. Availability of technical guidance	[ ]	....
2. Increased income	[ ]	....
3. Availability of production input on time	[ ]	....
4. Availability of credit	[ ]	....
5. Increased crop yield	[ ]	....
6. Prevention of loss	[ ]	....
7. Better quality grain	[ ]	....
8. Early maturing	[ ]	....
9. Drought resistant	[ ]	....
10. Better quality of seeds	[ ]	....
11. Less risky	[ ]	....
12. Innovation simple to adopt	[ ]	....
13. Recognition in community	[ ]	....
14. Taste quality	[ ]	....
15. Ease of Cooking	[ ]	....
16. Grain size	[ ]	....

17. Others (specify) ....

Which of these do you consider most important? Which next ... The least important?

41. What are your reasons for not growing "agric maize"? (please tick the appropriate reasons).

Reason(s)	Rank
1. Lack of technical guidance	[ ] ....
2. Lack of production input (seeds)	[ ] ....
3. Lack of fund	[ ] ....
4. Lack of knowledge	[ ] ....
5. Very expensive	[ ] ....
6. Poor quality grain	[ ] ....
7. More labour required	[ ] ....
8. More disease and pest problems [ ]	....
9. No real benefit	[ ] ....
10. Extensive Management	[ ] ....
11. Very complex to understand	[ ] ....
12. Supplies not on time	[ ] ....
13. Labour not available	[ ] ....
14. Lack of market	[ ] ....
15. Does not store well	[ ] ....
16. Neighbours do not use	[ ] ....

17. Others, specify ....

42. With respect to the maize varieties that you currently cultivate, please provide the following information

FIELD NO	SIZE (Ha/Ac)	VARIETY GROWN	SOURCE OF SEED	QUANTITY PURCHASED	PURCHASED PRICE	SOURCE OF INFORMATION ON VARIETY	NO. OF YEARS OF GROWING	REGULAR OF SEED SUPPLY

* 1 = "Agric"

a = Dobidi d = Abeleehi g = Dorke - SR

b = Okomasa e = Aburotia h = Safita 2

c = Obatanpa f = Golden Crystal i = Kwanzie

2 = Local

** 1 = Farmer's Own Seed 2 = From another farmer

3 = Seed dealer/market 4 = Global 2000

5 = MOFA 6 = Other (specify)

*** Regularity of Supply : 1 = Very Regular 2 = Regular 3 = Not Regular

43. Have you grown an improved maize variety in the past and later stopped using it?

1. Yes (Name variety) ....

2. No

44. Why did you stop using the variety?

....

....

III C. APPLICATION OF CHEMICAL FERTILIZER

45. Have you ever used fertilizer on maize?

    1. Yes [ ] 2. No [ ]

46. How many years ago did you start using chemical fertilizer on your maize farms?

    ....

47. Did you use any chemical fertilizer on your maize farms this growing season?

    1. Yes [ ] 2. No [ ]

48. If yes, which type?

    1 = Compound fertilizer (NPK)

    2 = Sulphate of ammonia

    3 = Urea

    4 = Others (Specify) ....

49. From which source(s) did you obtain the chemical fertilizer used on maize farm this cropping season?

FIELD NO.	*SOURCE(S)	MODE OF PAYMENT		PRICE/50KG	QUANTITY PURCHASED	QUANTITY APPLIED/ PLOT
		CASH	KIND			

* 1 = MOFA 2 = Private Shop/Market 3 = Global 2000

4 = other (Specify) ....

50. If payment is in 'Kind', what is the nature of payment?

....

51. Give me your reasons for using chemical fertilizer in your farms. Pleas(tick the appropriate reasons. Which of these do you consider mos important? Which next, ... then the least important?

Reasons(s)		Ranking
1. Availability of technical guidance	[ ]	....
2. Increase crop yields	[ ]	....
3. Increased income	[ ]	....
4. Availability of input (for fertilizer)	[ ]	....
5. Supply of input on time	[ ]	....
6. Availability of credit	[ ]	....
7. Innovation simple to adopt	[ ]	....
8. Availability of labour	[ ]	....
9. Less risky	[ ]	....
10. Recognition in community	[ ]	....
11. Other, specify		

52. What are your reason(s) for not using chemical fertilizer on your maize farms. Please tick the appropriate reason(s).

Reason(s)	Rank	
1. Lack of technical guidance	[ ]	....
2. Lack of production input (for fertilizer	[ ]	....
3. Very expensive	[ ]	....
4. Lack of Credit	[ ]	....
5. More labour required	[ ]	....
6. Labour not available	[ ]	....

7. More disease and Pest problems [ ] ....
8. No real benefit [ ] ....
9. Extensive management [ ] ....
10. Very complex to understand [ ] ....
11. Supply not on time [ ] ....
12. Neighbour do not use [ ] ....
13. Land not available [ ] ....
14. Others (Specify) ....

53. Have you used chemical fertilizers on maize farm in the past and later stopped using them?

1. Yes [ ] 2. No [ ]

54. If yes to question 53, why did you stop? Please rank your reasons.

Ranking:

1 = very important 2 = important 3= not important

Reason(s)		Rank
1. No need for fertilizer	[ ]	....
2. High cost	[ ]	....
3. Lack of funds	[ ]	....
4. Others specify	[ ]	....

III.D. APPLICATION OF TRACTOR PLOUGHING

55. Did you plough any of your maize plots this growing season?

1. Yes [ ] 2. No [ ] go to question 58)

56. How many years ago did you start ploughing your maize plots?

....

57. Give me your reason(s) for ploughing your maize plots. (Please rank you reasons using the following ranks)

1 = Very Important 2 = Important 3. Not Important

<u>Reason</u> Ranking

1. Ease of cultural practices [ ] ....
2. Availability of service/equipment [ ] ....
3. Availability of credit [ ] ....
4. Increased crop yield [ ] ....
5. Recognition in the community [ ] ....
6. Increased income [ ] ....
7. Others, specify ....

58. Give me your reason(s) for not ploughing your maize plot? (please rank your reasons using the following scale:

1 = very important 2 = important 3 = Not important

<u>Reason(s)</u> <u>Rank</u>

1. Very expensive [ ] ....
2. Lack of service/equipment [ ] ....
3. Lack of credit [ ] ....
4. Service not available on time [ ] ....
5. Loss of soil fertility [ ] ....
6. No real benefit [ ] ....
7. Land not adequate [ ] ....
8. More labour required [ ] ....
9. Neighbours do not plough [ ] ....
10. Others, please specify ....

59. If you ever ploughed your plots but no longer do so, why not?

1. High cost [ ]
2. Lack of fund [ ]
3. Difficulty in getting services [ ]
4. Others (specify) ....

60. Do you own a tractor?

1. Yes [ ] 2. No [ ]

61. If yes, how much of maize plots did you plough this season?

....

62. How do you plough your maize plots?

1. Hiring
2. Friends/Relatives
3. Others, specify ....

63. Of the total number of plots cultivated, how many did you plough?

Number : ....

Total size ploughed: ....

64. How much ~~much~~ did it cost you to plough each of plots ploughed this season?

PLOT NO.	SIZE (ac/ha)	COST OF PLOUGHING

IV. TECHNOLOGICAL CAPACITY TO SUPPORT IMPROVED TECHNOLOGIES

65. Did any agricultural extension officer visit/contact you during the last two years (1993 and 1994)?

Year	Visited by Extension Staff	No of visits
1993	Yes [ ] No [ ]	....
1994	Yes [ ] No [ ]	....

66. What is the name of the agricultural project for which the extension worker with whom you are in contact works?

1. MOFA [ ]
2. Global 2000 [ ]
3. Other (Specify) [ ]

67. What was the purpose(s) of the extension worker's visit and what were some of the major issues/themes discussed?

<u>Purpose(s) of Visits</u>   <u>Issues/Themes Discussed</u>

68. Did you implement any of the issues/themes discussed with the extension worker on your maize farming activities this cropping season?

1. Yes (Specify) ....
2. No (Why not?) ....

69. During the last five years, have you attended any agricultural field days at an experimental or research station?

1. Yes [ ] and Year ....
2. No [ ]

70. If yes to question 69 indicate some of the major issues or new practices that you were exposed to at the field day.

....

....

71. Have you implemented any of the new practices you learned at the field day on your maize farming activities?

1. Yes (Specify) ....

2. No (Why not?) ....

72. **Sources of Information about Improved Maize Production technologies.** From which source(s) do you get information on maize production technologies and how often (what is the frequency), please tick were applicable .

SOURCE OF INFORMATION	VERY OFTEN	OFTEN	RARELY	NEVEI
1. Friends/relatives				
2. Village Chief/ Traditional Ruler				
3. Extension workers				
4. Mass Media (Television, Radio)				
5. Cooperative farmers union/crop association				
6. NGO				
7. Children in School				
8. Posters/Pamphlets				
9. Field Days				

73 OWNERS OF TRACTORS

a. What is your main source of inputs (fuel, and spare parts?)

....

b. How regular is the supply? Tick

1. Very regular [ ]
2. Regular [ ]
3. Not regular [ ]

c. How often do you service your tractor in a year?

....

d. Where do you service your equipment?

....

....

e. How far is the service center/workshop from residence/farming sites?

....

f. On the average, how much do you spend on servicing per season?

....

g. How do you rate the services of the workshop/servicing centers?

1. Very Efficient [ ]
2. Efficient [ ]
3. Inefficient [ ]

h. How much do you set aside as depreciation for each year?

....

i. Number of workshop within area? ....

j. Number of Input Supply Centres within the area

....

74. **FINANCIAL INSTITUTION**

a. Do you have any financial institutions here which support maize and other agricultural production activities?

1. Yes [ ] (Specify number and Type)

....

2. No [ ]

b. Do you get any support in term of credit/loan facilities from these financial institutions?

1. Yes [ ] 2. No [ ]

c. How often is the service mentioned in (b) available?

1. Very often
2. Often
3. Rarely/seldom
4. Other, (specify) ....

d. What rate of interest do you pay on money taken from financial institutions?

....

e. i. How far is the nearest bank from your locality?

....

ii. Which bank? ....

75. **STORAGE FACILITY (SILO)**

a. Do you have any government owned storage facilities in your area?

1. Yes [ ] 2. No [ ]

b. If yes to question (a), do you store your maize at the available storage facilities?

1. Yes [ ] 2. No [ ]

c. What is the cost involved in using the storage facility (silo) for storing your maize?

....

d. Please give me your reasons for storing your maize in the silo?
....

e. What are your reasons for not storing your maize in the silo?
....

76. **MARKETING FACILITIES (Please circle the appropriate response**

A. How do you normally sell your maize?

1. Through middlemen
2. Through Ghana Food Distribution Corporation
3. Others, specify ....

b. Where do you normally sell your maize?

1. On the Local market
2. Market outside locality (Specify where ....)
3. To Ghana Food Distribution Depots located in the area
4. Others (Specify) ....

c. If product (maize) is sold on markets outside locality:

i. What is the mode of transportation of product?
....

ii. How reliable is the mode of transport?
1. Very reliable [ ]
2. Reliable [ ]
3. Not reliable [ ]

iii. What is average cost of transporting a unit of product from locality to the marketing centre?
....

iv. Do you pay any market toll on produce marketed outside the locality?
1. Yes [ ] 2. No [ ]

v. If yes to question (iv) how much do you pay per unit of produce?
....

vi. Please give me your estimation of other costs you incur i marketing your produce outside your locality?

....

vii. What problems do you have in marketing your produce?

....

77. **For each of the statement below please indicate whether you Strongly Agree (SA), Agree (A) or Disagree (D). Please tick .**

STATEMENT	STRONGLY AGREE	AGREE	DISAGI
1. I would plough my land only if I am planting "agric'maize			
2. I would apply fertilizer if only I plough my land and plant "agric" maize			
3. I would apply fertilizer even if I plant local variety			
4. I would plough my land even if I plant local variety			
5. I would plough my land, grow "agric" maize and apply fertilizer at the same time			
6. I would plant "agric" maize only If I can plough my land			
7. I would plant "agric maize only if I can get money to buy fertilizer to apply			
8. I would plant agric, only if I can plough my land and at same time be able to apply fertilizer			
9. I would not plough or apply fertilizer even If I plant "agric" maize			

78. Have you heard about the following government policies - Structural Adjustment Programme? and Privatization and Value Added tax?

1. Yea [ ] 2. No [ ]

79. If yes to question 78, Has any of these policies influenced your farming activities?

1. Yes [ ] .... 2. No . [ ]

b. If yes, describe how?

....

....

80. Why do you cultivate maize?

....

....

81. a. What are your main sources of income?

1. Farm

2. Non-Farm

3. Other (Specify)

b. My annual income falls within.

1. Less than ¢50,000

2. ¢50,000 - ¢100,000

3. ¢101,000 - ¢200,000

4. ¢201,000 - ¢1million

5. More than ¢1million

c. What percentage of your total annual income is obtained from non-farm activities?

1. Less than 25%

2. 50%

3. 75%

4. More than 75%

5. None

QUESTIONNAIRE FOR EXTENSION STAFF (FRONT LINE STAFF)

LOCATION OF EXTENSION WORKER: ....

EXTENSION WORKER: ....

Designation of Extension officer: ....

---

1. What improved maize production technologies have you diffused in the area in the past five years? (Please List)

   ....

   ....

3. What programme delivery methods have you employed in your activities?

   ....

   ....

4. a. Have you evaluated any of your programmes in the area?

   1. Yes [ ] 2. No [ ]

   b. If yes, to question 3a, which of the improved maize production technologies are farmers adopting? Please list

   ....

   ....

   ....

c. In your view what factors or reasons accounted for the technologies adopted?

....

....

d. What factors accounted for the non-adoption of the other improved maize production technologies diffused?

....

4. Do you think extension activities have contributed to increased yields in area?

1. Yes [ ] 2. No [ ]

5. Please indicate by ticking the appropriate response, the facilities readily available in area to support the various improved maize production technologies that you have extended.

FACILITY	YES	NO
1. Improved Seed dealers/seed depots		
2. Fertilizer sale Depots		
3. Storage facility (Silo)		
4. Efficient marketing channels		
5. Financial Institutions that readily offer credit facilities to farmers		
6. Ghana Food Distribution Corporation purchasing depot		
7. Workshops/spare parts shops		
8. Others (Specify)		

b. How do you rate the services offered by these facilities?

1. Very good 2. Good 3. Poor

6. What is the ratio of farmers to extension officer in your district/area of operation?

....

7. a. How many times do you visit an individual farm in a month?

b. During a visit what are the major issues or themes discussed?

QUESTIONNAIRE FOR OFFICER-IN-CHARGE OF STORAGE FACILITIES (SILO)

LOCATION OF SILO: ....

OFFICER-IN-CHARGE: ....

DESIGNATION OF OFFICER: ....

---

1. When was the silo built? 19 ..... (Year)

2. What was the main objective(s) for building the silo?

....

....

3. What is the total capacity of the silo?

....

4. Please tell me the services offered by your outfit to small-scale maize farmers?

....

....

5. What conditions govern the storage of produce by small scale farmers in silo:

   a. Cost or charges per unit product stored

   ....

b. How much produce can a farmer store?

....

c. When can farmers store their products in silo?

....

6. During the lst three years, 1992, 1993, and 1994, how many farmers have used these facilities?

Year	No of farmers
1992	....
1993	....
1994	....

7. What percentage of silo capacity has been utilized in last 3 years?

Year	Percentage Capacity Utilization
1992	....
1993	....
1994	....

8. How and when is the stored product disposed off?

....

9. What are the main reasons for:

i. Usage of silo by farmers?

....

ii. None Use of Storage facilities by farmers?

....