UNIVERSITY OF CAPE COAST

THE DISSEMINATION AND ADOPTION OF COCOA PRODUCTION TECHNOLOGIES IN GHANA

KYEI MENSAH

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BY

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A THESIS SUBMITTED TO THE DEPARTMENT OF AGRICULTURAL ECONOMICS AND EXTENSION OF THE SCHOOL OF AGRICULTURE, UNIVERSITY OF CAPE COAST IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DOCTOR OF PHILOSOPHY DEGREE IN AGRICULTURAL EXTENSION

SEPTEMBER 2006

Candidate's Declaration

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

Date 13-09-06

KYEI MENSAH

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

The study examined the dissemination and adoption of cocoa production technologies in Ghana. The aim was to improve cocoa extension and adoption of technologies to ensure higher yield. The study identified twenty-five technologies and examined the communication factors that influenced the adoption of the technologies. Farmers' background characteristics and farm related factors were also studied. In addition, the study examined the relationships between the level of adoption of the technologies and background characteristics of farmers as well as the farm related factors. The study also identified constraints and best predictor variables of adoption.

The results of the study revealed that farmers combined both traditional and science-based technologies in their farming systems. The unified extension system under the Ministry of Food and Agriculture functioned at a lower intensity, as perceived by cocoa farmers, compared with extension provided by the staff of Ghana Cocoa Board. Members of staff of Ghana Cocoa Board remained the major extension providers to cocoa farmers. Most farmers sought information on production-oriented technologies and paid little or no attention to post-harvest technologies. Most farmers preferred the production technology approach and the group method of extension.

On the whole, simple, low cost and locally readily available technologies received higher rate of adoption, unlike expensive, foreign, and complex technologies. The over-all level of adoption of technologies was moderate. Farmers in Brong Ahafo Region had the highest level of adoption

of technologies. Adoption levels differed significantly among districts and over time. Males dominated cocoa farmers in the study. Most farmers were aged or ageing, educated, experienced, and had five household members.

Most farmers could not save from the sales of their produce. Sources of labor included family, hired, communal, and caretakers. Most farmers did not own high cost machinery but could borrow from their localities. The yield of cocoa increased over a three-year period. The mean yield was 384.7 kg/ha. The Cocoa Diseases and Pests Control and "High Tech" Programs apparently contributed to the increasing trend of production. Recent gains in cocoa production should not be signals for complacency. Farmers need to consolidate and build upon the gains to ensure higher production.

Constraints to the adoption of technology were lack of credit, high cost of inputs, labor shortage, and old age of farmers. The best predictor variables of adoption were household size and credit availability. The farm household contributed significantly to cocoa production. Any meaningful development program should center on the household. There is the need to expand credit and savings schemes to assist farmers. For technologies to have full adoption, researchers should address the needs of farmers. Researchers should also develop economically feasible and low cost technologies. Trained extension workers should, of necessity, effectively disseminate innovative practices to farmers to ensure increased production.

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DEDICATION

To my father, Enoba Kwabena Duku Mensah, I dedicate this thesis.

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LIST OF ACRONYMS

AKIS	Agricultural Knowledge and Information Systems
CCSFA	Cocoa Coffee Sheanut Farmers Association
CMB	Cocoa Marketing Board
COCOBOD	Ghana Cocoa Board
CODAPEC	Cocoa Diseases and Pests Control
CRIG	Cocoa Research Institute of Ghana
CRP	Cocoa Rehabilitation Project
CSD	Cocoa Services Division
CSSVD	Cocoa Swollen Shoot Virus Disease
EFA	Extension Field Assistant
FAO	Food and Agriculture Organization
FM	Frequency Modulation
FPR	Farmer Participatory Research
FSR	Farming Systems Research
KAP	Knowledge, Attitude and Practice
LBC	Licensed Buying Company
MOFA	Ministry of Food and Agriculture
PBC	Produce Buying Company
PLA	Participatory Learning Action
PPRC	Producer Price Review Committee
PRA	Participatory Rural Appraisal
SEC	Strategic Extension Campaign
SPU	Seed Production Unit
SPSS	Statistical Product and Service Solutions

CHAPTER ONE

INTRODUCTION

Introduction

The chapter introduces the reader to the background to the study of cocoa production, technologies dissemination and adoption in Ghana. The statement of the problem follows this. The objectives, research questions, research variables and hypotheses of the study are also stated in the chapter. Other aspects covered in the chapter include delimitations, limitations and justification of the study as well as definition of terms. The chapter ends with the organization of the study.

Background to the Study

In spite of the significant gains made by other sectors of the economy in recent times, agriculture is a critical strategic resource in the Ghanaian economy. Cocoa, *Theobroma cacao*. L is a major export crop with over a hundred years of history in Ghana. Cocoa was introduced into Ghana during the late Nineteenth Century and, in the early Twentieth Century, Ghana became the leading producer of cocoa. Ghana remained the leading producer for almost a century.

According to Vos and Krauss (2002), cocoa is a fundamental component of the rural livelihood system, with farmers committed to the crop. Cocoa cultivation is a 'way of life' and the farmers are very much attached to the crop socio-culturally. The economic and social importance of cocoa can scarcely be exaggerated. Varley and White (1958) noted that there were few people in Ghana whose welfare was entirely independent on cocoa. The level of social and economic development, in the 1950s, so much higher than most countries in sub-Saharan Africa, was due almost entirely to the continued growth and prosperity of the cocoa industry. Cocoa provides employment and farmer income for a sizeable proportion of the labor force, foreign exchange earnings and Government revenue. It is therefore, an important source of poverty reduction.

In Ghana, cocoa is produced in the forest belt. The Eastern and Ashanti Regions are the early or pioneer cocoa zones, whereas the Central Region, Brong Ahafo Region, Volta Region and Western Region are the new cocoa zones, with the Western Region being the latest cocoa zone. The cocoa growing areas of Ghana are shown in Appendix II. Cocoa production in Ghana occupies about 1,195,057.12 hectares as shown in Table 1

Table 1: Regional Distribution of Cocoa Areas

Region	Area (Ha)	Percentage	Cum. %
Western	493,382.51	41.3	41.3
Ashanti	290,471.80	24.3	65.6
Eastern	172,131.41	14.4	80.0
Brong-Ahafo	127,903.20	10.7	90.7
Central	80,088.90	6.7	97.4
Volta	31,079.30	2.6	100.0
Total	1,195,057.12	100.0	

Source: COCOBOD Cocoa Tree Stock Surveys, 1997

Ghana has comparative and competitive advantages in cocoa production. These include specialized skills of farmers in producing high quality beans. Farmers produce the beans under environmentally friendly conditions. Ghana's cocoa has virtually limitless demand on the world market. However, a number of factors constrain the sustainability and competitiveness of cocoa production in Ghana. These include capsid and black pod disease attack, mistletoe infestation and declining soil fertility. Other factors are low yielding cocoa varieties, poor plant densities and inappropriate shade and unremunerative producer price, which tend to stimulate a switching of resources to the production of food crops rather than cocoa in the cocoa belt. The rest are factors like lack of credit, poor road and other infrastructure shortage (Ministry of Finance Report, 1998)

Current efforts to boost cocoa production include the mass spraying exercise by which cocoa farms throughout the country are sprayed free of charge by the Cocoa Diseases and Pest Control Program (CODAPEC). Another way of boosting production is the 'Hi-tech' Program, which aims at increasing yield by application of technologies developed by the Cocoa Research Institute of Ghana (CRIG). The control of the cocoa swollen shoot virus disease (CSSVD) is an on-going activity to map out all outbreaks of the disease, cut out infested trees and assist farmers to replant their farms with hybrid materials that are tolerant to the disease. Ghana produced a record of 736,200 tones during the 2003-2004-crop season. It is believed that the tonnage achieved in 2003/2004-crop season was partly the result of these measures. Government desires to increase cocoa output to 800,000 tones by 2009/2010

Cocoa farmers in Ghana enjoy a better market for their produce than their counterparts in neighboring countries. This is due to the guaranteed price the government pays them. The government also pays bonuses during off-season period to give a further boost to cocoa production. The major objectives for increased production in the years ahead include the following:

- To provide extension education to farmers to enable them pursue good husbandry practices for increased yield per hectare.
- To intensify research work into various aspects of the cultivation and maintenance of cocoa;
- To encourage through research and demonstration the re-establishment of cocoa in denuded areas where cocoa was formerly cultivated and where annual rainfall remains sufficiently high;
- To encourage private sector participation in the internal marketing and in several other operational areas of the cocoa industry.
- To promote local cocoa processing to obtain added value;
- To maintain the quality of Ghana's cocoa beans so as to retain the traditional premium obtained on Ghana's cocoa in the world cocoa market; and
- To secure the most favorable arrangements for the purchasing, inspection, grading, sealing, and certification, sales and export of cocoa (Ghana Cocoa Board, 2000).

In the long term, the path to increased production of cocoa should pass through a phase of improved productivity. Farmers can achieve this through sustainable technology development, dissemination and adoption of improved technologies. The key elements towards this goal are research capability and ability, an extension network with effective delivery system and the seriousness with which Ghanaian farmers adopt improved technologies

Statement of the Problem

The average productivity of cocoa farmers in Ghana has been very low, specifically about 400kg/ha (Ampofo, 1990), compared with 800 kg/ha in La Cote D'Ivoire or 1,700 kg/ha in Malaysia (Cocoa Services Division, 1981). Farmers' low output consequently leads to massive reduction in national output, a decline in foreign exchange and lowering of the living standards of the people.

Increases in cocoa production in Ghana have largely been achieved through the expansion of production in the virgin forest areas rather than increases in productivity. However, this results in forest depletion, environmental degradation and adverse climatic changes. The option of expanding areas under cultivation is approaching its limits. Pressure of land for food crops due to population increase has also taken away some of cocoa lands (MASDAR Consultancy Report, 1997). The potential to increase output lies in the intensification on existing cocoa farms, rehabilitation of abandoned farms and replanting in old areas.

Cocoa production in Ghana has predominantly been on small scale. Ghana's superior quality cocoa owes much to the post-harvest management and processing of the beans by small holders handling relatively small quantities. The use of mechanical dryers, which will be suitable for large output of cocoa from large plantations, reduces the flavor that comes out of the fermentation and sun drying. Thus, for Ghana to increase and sustain production with prevailing quality, it is important to devise effective schemes to improve productivity of small-scale farming

Ampofo (1990) observed that Ghana has the potential to double production as research information indicates that the country possesses sufficient technologies to raise the average yield to over 1,500 kg/ha with appropriate technologies and agronomic practices The problem is to identify those technologies. Another problem is to find out the awareness of those improved technologies among cocoa farmers

Ekpere (1995) concluded that despite the long and impressive list of innovations from research. African small-scale farmers remain relatively unaware of or lack the skills and resources to take full advantage of available agricultural research results. A cocoa survey in Ghana, conducted by Vos and Krauss (2002), revealed that farmers' knowledge of pest ecology, pest management, crop nutrition, and cocoa product quality was extremely poor with the exception of those farmers who had been actively involved in on-farm research by the national cocoa research institute (CRIG)

Thus, it is not enough to develop technologies for farmers, but ensure they become innovative through extension education. However, MASDAR Consultancy Report (1997) further revealed that extension workers generally lack the expertise of presenting technologies to farmers The report noted that inadequate and ineffective performance in extension delivery affected technology adoption in Ghana. According to Cocoa Services Division (1997) out of 11 innovations recommended, only two, namely, removal of mistletoes and removal of unwanted basal chupons on cocoa, attained 60 per cent level of adoption. Moreover, Asante-Mensah (1988) observed that less than one-third of respondents adopted eight practices studied.

Currently, cocoa extension is under the unified extension services of the Ministry of Food and Agriculture (MOFA). The merger of the extension wing of Cocoa Services Division of Ghana Cocoa Board with MOFA was to ensure cost-effectiveness. However, Abina (1994) concluded that a unified extension system could not respond adequately to widely varying agro-ecological conditions, complex industrial and environmental requirements and economic, social, as well as cultural differentiation among rural populations. The question is: are cocoa farmers benefiting from the merger? The answer to this question and the problems associated with the transfer of technology are the concerns that the study seeks to address. The current cocoa extension needs to be revisited in order to achieve more sustainable production.

The success of measures to improve the productivity of farmers largely depends on the adoption of the recommended practices, which would result in increases in yield per hectare. Appiah (2004) warned that Ghana's cocoa industry would not survive unless there is an infusion of farmer dynamism and utilization of research findings to improve production. He further pointed out that cocoa remains a key foreign exchange earner, as well as domestic income booster, hence, there was the need for the farmers to be innovative to maximize the desired benefits, instead of relying on traditional methods of cultivating the crop. It is, therefore, important to understand the adoption behavior of Ghanaian cocoa farmers and the factors that influence their adoption or rejection of recommended practices.

The socioeconomic and background factors related to the cocoa farmers play a major role in the adoption of technologies. Such vital data and information on cocoa farmers' adoption behavior, their background characteristics and farm-related factors influencing the adoption of the recommended practices in the whole country, are unfortunately, lacking or scanty. These factors will, therefore, be the focus of this study.

A growing scientific interest in locally developed farming systems and technologies is gaining grounds. Incorporating farmers' knowledge and practices into formal research programs will make cocoa production strategies more sustainable towards increasing yields. According to Reijntjes, Haverkort and Waters-Bayer (1992), locally adopted cultivars and practices lead to sustainable use of local resources. However, cocoa farmers rarely document their knowledge and farming systems, which, according to Scoones and Thompson (2000), are valuable and under- utilized resources.

According to Vos and Krauss (2002), it is now widely acknowledged that low adoption is partly due to inappropriate research results and lack of integration of research and farming knowledge, viz. farmers' constraints and indigenous technologies. The study focuses on the identification and examination of cocoa production practices by Ghanaian farmers for the attention of researchers. Johnson and Kellogg (1984) noted that accelerating development in economies with large agricultural sectors, like Ghana, requires the development, adaptation and evaluation of agricultural technologies that farmers adopt. Herein lies the need to undertake this study.

Objectives of the Study

The general purpose of the study was to examine Ghana's cocoa production, technologies dissemination and adoption, with a view to making cocoa extension more effective in responding to farmers' needs towards sustainable increase in production

Specifically, the objectives of the study were to:

1. Identify current production technologies available for adoption by farmers;
2. Examine the technologies involved in cocoa production by Ghanaian farmers;
3. Examine the communication factors associated with the dissemination of cocoa production technologies to farmers with regard to actors, messages, approaches and channels;
4. Determine the rate and level of adoption of the identified recommended production technologies by farmers.
5. Identify constraints that limit the adoption of technologies by farmers;
6. Describe the personal and background characteristics of cocoa farmers in Ghana with respect to sex, age, educational level, experience and household size;
7. Show how the personal and background characteristics relate to level of adoption of technologies.
8. Explore farm related factors involved in the production of cocoa including farm size, labor, credit, equipment/machinery, land tenure, yield, marketing and price of produce.

Research Questions

The following questions guided the study in seeking answers to relationships between variables, which ultimately gave explanations or solutions to the problem situations.

1. What production technologies are available for farmers' adoption?
2. What are the technologies employed by farmers in cocoa production in Ghana?
3. How do the actors, approaches, messages and communication channels employed by the extension service influence farmers' adoption of technologies?
4. What are the rate and level of adoption of selected cocoa production technologies among cocoa farmers in Ghana?
5. From cocoa farmers' point of view, what factors limit the adoption of technologies?
6. What are the personal and background characteristics of cocoa farmers as regards age, sex, educational level, experience and household size?
7. Are there any relationships between the age, educational background, experience and household size of cocoa farmers and level of adoption cocoa technologies?

9. Show how farm size, labor availability, credit availability, number of equipment, land tenure arrangement and cocoa yield relate to the level of adoption of technologies; and

10. Identify the best predictors of cocoa adoption from the variables of the

8. How can the farm size, labor, credit, equipment, land tenure, marketing and price of produce of cocoa farmers be described?

9. What is the relationship between farm size, labor availability, credit availability, number of equipment, land tenure arrangement and yield of cocoa and the level of adoption of technologies?

10. From the variables of the study, what are the best predictors of cocoa production technology adoption?

Research Variables

The study focused on the following dependent and independent variables.

Dependent Variables

The dependent variables in the study are rate and level of adoption of recommended cocoa technologies.

Independent Variables

The independent variables in the study include the following practices grouped into different categories.

Pre-planting Practices

1) Site selection, 2) soil testing, 3) land preparation, 4) shade establishment, 5) row spacing, 6) lining and pegging and 7) optimum crop density.

Nursery

1) Nursery raised seedlings, 2) seedlings in polythene bags and 3) hybrid variety.

Planting

1) Period of establishment, 2) time of planting, 3) sources of planting materials and 4) method of planting.

Maintenance

1) Regular weeding, 2) removal of basal chupons, 3) shade manipulation, use of pruners, 4) pruning and 5) provision of adequate drainage

Chemicals Application

1) Herbicide, 2) mineral fertilizer, 3) fungicide and 4) insecticide

Harvest and Post-harvest

1) Regular harvesting, 2) fermentation of fresh beans, 3) stirring of beans during fermentation and 4) burial of pod debris after pod breaking

Other independent variables include personal and background characteristics of farmers as well as farm related factors.

Personal and Background Characteristics of Farmers

1) Age, 2) educational level, 3) sex, 4) experience and 5) household size

Farm Related Factors

1) Farm size, 2) labor, 3) credit availability, 4) number of equipment, 5) land tenure arrangement, 6) yield and 7) marketing and price of produce

Research Hypotheses

The hypotheses that are of interest in guiding the analysis of results are

1. Ho: There are no significant relationships between the age, educational background and experience and household size of farmers and level of adoption of technologies.

   Hi: There are significant relationships between the age, educational background, experience and household size of farmers and level of adoption of technologies

2. Ho: There are no significant relationships between farm size, labor availability, credit availability, number of equipment land tenure arrangement and yield of produce and the level of adoption of technologies.

   Hi: There are significant relationships between the farm size, labor availability, credit availability, number of equipment, land tenure arrangement and yield of produce and level of adoption of technologies

Delimitations of the Study

Delimitations of the study are the following

1. Boundaries or confines of the study covered only one district in each of the cocoa growing regions of Ghana.
2. Only cocoa farmers with mature farms constituted the population for the study.
3. Only five villages in each district of the regions formed part of the study areas

Limitations of the Study

The study anticipated the following limitations

1. In the absence of adequate record keeping by farmers, the study relied on farmers' power of recall. Essentially, the respondent was asked to look back in time and reconstruct his or her past history of innovation experiences. This hindsight ability was clearly not completely accurate.
2. Trained enumerators interpreted the questions to farmers from English to Akan and Ewe local languages. The enumerators again translated the responses from local languages to English. There could be limitations in giving correct interpretations

Justification

The study will make extension agents and farmers aware of technologies available for dissemination and adoption. The study would create greater understanding of current cocoa production practices and constraints. The study would document the local production practices and farming system. Such information would become available to researchers, who could then incorporate the information into formal research programs to develop appropriate technologies for increased cocoa production. Researchers would also know more about the extent of adoption of technologies and factors, which affect adoption of these technologies. This knowledge would guide researchers to make the research more adaptive, taking into consideration the special needs and constraints of farmers

It is important to determine if the current unified extension system meets expectation of increased productivity by cocoa farmers. The study sought to assess the current delivery of cocoa extension and come out with the capacity of the extension system to offer responsive programs, appropriate messages, channels and approaches, capable of serving efficiently, cocoa producers at all levels. Management and policy makers of extension organizations would gain more knowledge of demographic characteristics of cocoa farmers as well as socioeconomic factors related to cocoa production. This knowledge would guide management and policy makers to effectively take decisions on extension programs in the country. We need to know the extent to which farmers adopt or reject the recommended technologies and the reasons for their adoption behavior, as well as the factors that best predict the adoption of technologies.

Based on the crucial role that information plays in the formulation and implementation of agricultural policies, the study could provide analyses to assist in setting priorities and constructing policies that would encourage better adoption of recommended innovations. Adoption of recommended technologies would, in turn, raise productivity of farms. Findings on farmers' adoption behavior from this study may be applicable to other situations in which small farmers of similar background grow other export-oriented cash crops such as coffee, oil palm and mangoes. This could assist in the search for better ways of facilitating the adoption of recommended practices of these crops by farmers.

Earlier research on adoption of cocoa technologies carried out by Asante-Mensah (1988), Dankwa (2001) and Asante (2002) concentrated only on Eastern, Ashanti and Brong Ahafo Regions. There is, therefore, the need to extend the studies on cocoa technology adoption to cover all the cocoa growing areas in the country. A constant review of the background characteristics and farm related resources of farmers could provide vital data and information on farmers' adoption behavior. The study could link the activities of researchers with farmers, institutions and the government. Moreover, the study would facilitate learning action among other stakeholders in the industry to promote cocoa production.

Among the audience expected to benefit from the research findings, in view of the data and information the study provided, which could ensure increased production, are the numerous cocoa farmers and their families. To them must be added all the other workers and their families who are directly or indirectly dependent on cocoa. They are the numerous hired laborers. Then there are the clerks concerned with buying and grading for export, the lorry drivers and the dockworkers engaged in transporting the crop. Beneficiaries of the project also include major contributors in agricultural investment, rural organizations that promote change in agriculture and political decision makers.

Definition of Terms

The following terms are defined within the context of the study.

Adoption: The acceptance and use of cocoa technology by farmers.

Adoption level: The number of technologies farmers use, out of the total number of technologies under study.

Adoption rate: The number of cocoa farmers using technologies identified as a ratio of the total number of farmers in the study over a period of time

Cocoa bean: The whole seed of the cocoa tree, fermented and dried

Cocoa farmer: A Ghanaian individual who owns and operates a unit of matured cocoa farm in Ghana.

Constraint: Any condition or a set of conditions that limit cocoa production, technology dissemination and adoption of technologies

Innovation: Something newly introduced, such as a new method, technique or device used in cocoa production.

Productivity: The output per unit of land, labor, capital, time or other inputs used in cocoa production.

Quality: In this study, the term refers to the all-important aspects of flavor, purity and the physical characteristics of cocoa beans that have a direct bearing on manufacturing performance.

Technology: The machines, tools, mechanical devices, planting materials instruments techniques and practices adopted for practical purposes of producing cocoa.

Organization of the Study

The study was organized into five chapters. The body of the study opens with an introduction contained in Chapter One that presents the background to the study, statement of the problem under study and the objectives of the study. Other aspects included in the chapter are research questions, research hypotheses and the significance of the study. The rest are delimitation, limitations and definition of terms.

Chapter Two presents the literature review. The search for the related literature is one of the first steps in the research process. The literature review is a summary of the writings of recognized authorities. This step provides useful hypotheses and helpful suggestions for significant investigation. Citing studies that show substantial agreement and those that seem to present conflicting conclusions help to sharpen and define understanding of existing knowledge about the study and provide a background for the research project. In addition, it provides a valuable guide to defining the problem, recognizing its significance, suggesting the data gathering device, appropriate study design and sources of data.

The methodology chapter of the research follows the literature review. The chapter describes in detail how the study was conducted and consists of three parts namely: subjects, procedures and data analyses. The subject's section details the population from which the sample is selected. The number of subjects desired from the population and how they are selected are also indicated in this section. The procedure section outlines the research plan. It describes in detail what is done, how it is done, what data are needed, and the data-gathering device used. Enough information is provided to permit replication of the study. The Statistical Product and Service Solutions (SPSS) have been used to analyze the data.

The results and discussions, which follow the methodology section, present the data from the statistical analyses. All relevant findings have been presented. Tables and figures supplement text material. Data in the text, figures and tables are complementary. The text indicates what the reader should expect to see in the tables so as to clarify their meaning. After presenting the results, the implications of the study follow. The discussions include both theoretical and practical applications of the study. Chapter Five presents a summary of the study and the conclusions drawn from the results of the study. Some recommendations for policy development have been made. The chapter ends with proposals for future research.

CHAPTER TWO

LITERATURE REVIEW

Introduction

This chapter reviews the existing theoretical and empirical studies, which provide the background and necessary basis for the study. It includes a review of cocoa production technologies involved in the establishment of cocoa farms and communication factors associated with dissemination of technologies. On the adoption of technologies, the chapter reviews some of the major developments in the literature related to the theory, examines its criticisms and discusses the implication for extension. In addition, the review deals with constraints and predictors of adoption. Background characteristics of farmers, farm-related resources and other socioeconomic factors that influence technology adoption also form part of the review. The chapter ends with the presentation of the conceptual framework of the study.

Cocoa Production Technologies

The section deals with technologies involved in the establishment and maintenance of cocoa farms. In addition, the section deals with harvest and post-harvest operations.

Establishing Cocoa Plantation

Mossu (1992) stated that well-organized land preparation would be beneficial to the cocoa tree's development. Hasty preparation eventually leads to many problems often difficult and costly to solve. The preparation of land takes place at least one year before planting out of the cocoa seedlings. Land preparation involves clearing, with shading arranged to be ready to shelter the young plants when they leave the nursery.

Temporary shading is indispensable during the early stages of the cocoa trees. Temporary shading provides windbreak. The temporary shading should be relatively dense, allowing through no more than 50 per cent of the total light for the first two years. Food crops usually provide temporary shading, which gives the farmer an initial return on the land. Examples are banana and plantain, which provide satisfactory shading six to nine months after planting. Fast-growing trees such as the *Gliricidea* species are in use in several countries as temporary shade.

Permanent shading forms a canopy over the adult plantation. The economic and practical advantages of having some overhead shade are to provide the optimum light intensity for optimal growth and yield and counteract rapid loss of soil fertility. Other advantages are to prevent adverse effect of wind velocity and excessive transpiration with its attendant soil moisture deficiency. This in turn causes undue water and nutrient stress and *ipso facto*, makes the tree susceptible to intensive insect pest attack.

Permanent shading generally consists of species retained as the forest is felled. Trees known to be hosts for insects or diseases likely to attack the cocoa tree must be eliminated. Examples are *Sterculiaceae and Bombacaceae* species *Leucaena leucocephala, Gliricidia sepium* and various *Erythrinae and Albizia* species provide permanent shade to cocoa plantations. The recommendation on shade is 15-20 overhead shade trees per hectare. Moderate shading is however considered as the safest and most economical method in most regions. Excessive shade is a common problem, lowering yields and encouraging Black pod disease (CRIG 1995).

Cocoa farmers normally establish their farms either by planting directly in the field (planting at stake) or by transplanting nursery-raised seedlings. In general, planting at stake is more economical since it uses no special plant growing facilities. However, direct seeding may result in poor establishment. This is because the young seedling has to compete with weeds for nutrient and moisture. The seedling is also exposed to rodents and insect pests (Freeman, 1965).

Several planting patterns can be adopted: in squares, in a staggered arrangement, in an equilateral triangle, in an isosceles triangle etc. But the simplest and most adopted pattern is to arrange them in equidistant rows, which greatly facilitates maintenance, supervision and plant health work. Stakes are used to mark each planting hole. Preparing the planting holes generally follows marking-out. Planting must take place as soon as the rainy season is established and as long as possible before the following dry season. Planting of the seedlings should also take place in the early hours of the morning. If necessary, planting should be at the end of the afternoon, but never during the hottest part of the day.

Plantation Maintenance

It is recommended that the planter should be vigilant, particularly, during the early years of the development of the plant. Maintenance also implies a rational management of time and means. The farmer's calendar should take account of the on-going operations, which can be carried out in rotation, such as weeding, pruning of cocoa trees, mistletoe control, fertilization and diseases and pests control.

Weeds compete with cocoa for nutrients and moisture from the soil and, thus, reduce the yield of cocoa. Weeds also encourage pests and create humid conditions in the farm, which increases the incidence of black pod disease. Farmers are advised to weed their farms 3 to 4 times a year. Weed control by hand weeding has been the usual practice in Ghana and is very expensive. Herbicides recommended for weed control in cocoa are *Grammozone and Roundup*. More time is saved when herbicides are used for weed control (Manu and Tetteh, 1987).

Pruning is the removal of unwanted growth or parts of the plant. Pruning gives shape to the trees and helps in farm operations. Pruning improves free airflow and opens the canopy to allow light to penetrate the farm. The incidence of black pod reduces by these conditions and the yield of crop increases. Unwanted shoots (suckers) and excess foliage are pruned in April/May and August/September each year (CRIG, 1995).

Mistletoe is a plant parasite, which grows on the branches of cocoa trees. It is controlled alongside pruning of unwanted shoots and excess foliage. It is removed twice in a year (CRIG, 1995).

In Ghana, the most important cocoa pests are capsids, which appear in two species namely *Distantiella theobroma* and *Sahlbegella singularis*. It is estimated that Ghana loses 25% of its annual crop to these insects (Ministry of Finance, 1998). Farms are to be sprayed once a month in August, September, October, and December with recommended insecticides (Manu and Tetteh, 1987).

The black pod disease is caused by two species of fungus, *Phytophthora palmivora* and *Pyhtophthora megakarya*, which attack the pods and turn them black within two to ten days. The damage caused by *P. magakarya* can be very extensive. The disease is common during the rainy season when the environment is wet and damp. There are two methods of control. They are the cultural and chemical methods. The cultural method aims at reducing humidity and increasing aeration, which do not favor the development of the disease. These can be achieved through judicious reduction of shade, regular weeding, removal of basal chupons, immediate removal of diseased pods from trees and regular harvesting.

Chemical control involves spraying to coat the pods with fungicides, which stop the germination or the growth of the fungal spores. The spraying starts at the beginning of the rainy season when there are enough pods on the trees and 5-8 diseased pods per hectare are seen. The spray is repeated at three weekly intervals until all pods are harvested. Some of the recommended fungicides are Kocide 101, Copper Nordox, Ridomil, Caocobre Sandox, and Champion (CRIG, 1995).

Appiah (1990) noted that the absence of essential plant nutrients in intensively cropped land is one of the major underlining causes of loss of cocoa farms. Thus, the use of fertilizer is first and foremost necessary to the farm as a producing entity and also to increase yield per unit area. The recommended rate of fertilizer application for mature cocoa is [illegible] kg of triple super phosphate and 5[illegible] kg of muriate of potash per acre. The application [illegible] done in March-May before the rainy season.

Harvesting and Post-harvest Operations

From the pollination of the flowers up to the ripening of the fruit, the formation and development of the pods take, on average, five to six months. The pods should be harvested when they are ripe, usually yellow or orange in color. Harvesting should be carried out at regular intervals of [illegible] to 15 days, which in any event should never exceed three weeks. During harvesting, it is important not to damage the flower cushion and the tree, which will make it easy for parasitic fungi to penetrate the tissues of the tree (Manu and Tetteh, [illegible]).

The pods are opened to remove the seeds. This operation should be completed no longer than six days after harvesting. The harvested pods are grouped together and split either in or at the edge of the plantation. Deep pit is dug into which to throw all the pod debris and rotten pods collected during harvesting. The simplest way of opening the pod is to use a wooden club.

In order to be sold as "cocoa beans", the fresh seeds removed from the pods undergo two important processes, namely, fermentation and drying. The production of high-quality cocoa, which is so much sought after today, depends directly on how these processes are carried out. Placing the fresh seeds in specially prepared containers, or more simply in piles, rapidly triggers the fermentation of the sweet mucilaginous pulp that surrounds each seed. Regular stirring of the entire mass is necessary to promote aeration and to obtain even fermentation. Stirring should generally be carried out every 48 hours.

The duration of the fermentation depends on the genetic structure of the selection, the climate, the volume of the mass undergoing fermentation and the method of fermentation adopted. Fermentation occurs on average from 2 to 6 days. The aim of drying is to reduce the water-content of the fermented beans which is approximately 60 per cent to less than eight per cent, to ensure that the cocoa is kept in good condition for storage and transportation. The methods adopted to dry cocoa can be divided into two main types: natural or sun-drying and artificial drying. After drying, the beans are packed in jute bags. The beans are sorted. Flat, broken, germinated beans and other impurities are removed before bagging. The international standards state that the net weight of a cocoa bag must be 62.5 kg i.e. 16 bags to one ton.

Cocoa beans have to be stored by the producer before delivering, the exporter before export and the processor before use. Cocoa of merchantable quality must have undergone even fermentation and drying. It must have moisture content of less than eight per cent. The product must not contain any foreign bodies or live insects, or any bean with a smoky or any other foreign odor and must not show any signs of deterioration. The beans should be reasonably uniform in size and there should be no broken beans or pieces of shell.

In Ghana, the Ghana Cocoa Board continues with the monopoly system of grading and sealing cocoa for export. A key element in this regard is to ensure that the quality of beans exported is sustained over the years to guarantee the earning of a premium on cocoa. Commercial grades are drawn up according to the percentages, which must not be exceeded, of faulty beans found during cut test. The international standards set by the Food and Agriculture Organization (FAO) and applied by most of the producing and consuming countries appear in Table 2

Table 2: Grading System for Commercial Cocoa (Percentages)

Standard	Mouldy beans	Slaty beans	Others
Grade I	3	3	3
Grade II	4	8	6
Ungraded	4	>8	>6

Source:Musso,1992

According to Ghana Cocoa Board (2000), technologies recommended for the establishment of cocoa farms in Ghana included optimum crop density, establishment of adequate temporary and permanent shade and weed control. Agronomic practices recommended for mature cocoa included spraying of insecticides against capsids pests (*Akate*) in August, September, October and December, control of overhead shade, mistletoe removal, removal of unwanted basal chupons, spraying fungicides against Black Pod disease as well as regular harvesting, pod breaking, fermentation and drying of beans

Gyamfi and Owusu (1979) noted that farmers in the Dunkwa District participated in a pilot extension project that featured improved technologies including site selection for cocoa planting, site preparation for a cocoa farm, lining and planting temporary shade. Others included planting recommended improved planting material, establishment of nurseries, maintenance of nurseries, maintenance of young cocoa farms to bearing age (1-3 years old) and maintenance of mature farms. The rest were prevention of capsid pests' attack, mistletoe control, identifying swollen shoot disease and its control, Black pod disease control and harvesting, fermentation, drying, bagging and storage.

Recommended technologies studied by Asante-Mensah (1988) included planting of hybrid and Amazon varieties, planting distance of 8 feet by 8 feet, regular weed control and spraying times for Capsid pest control. Others were dilution of insecticides, Black pod disease control by chemical and cultural means and swollen shoot virus disease control. The rest were mistletoe control and harvesting times.

Dankwa (2001) also studied the following recommended technologies extended to farmers: raising cocoa seedlings before planting, line planting of seedlings, and regular brushing of cocoa farm, removal of unwanted basal chupons and removal of mistletoes. The rest were insecticide spraying to control pests, fungicidal spraying to control Black pod disease and provision of necessary shade on the plantation. Asante (2002) further recommended the following technologies: shade establishment, pruning, weeding, (at least three times per year) and capsid control, (sprays four times per year). The rest were Black pod control, (sprays more than four times per year), mistletoe control (two times per year) and harvesting, (two to four weekly intervals).

Farmers' Traditional Practices

On farmers' traditional management practices, MASDAR Consultancy Report (1997) noted that the norm is low levels of technology usage. Farmers do not adopt or partially adopt recommended agronomic practices. Farmers' traditional practices involve pruning, which may be performed at weeding and haphazardly done, weeding performed twice a year in May/June and September/October and no fertilizer application. Capsid may be controlled when damage is severe, harvesting done only when majority of pods on the trees is ripe and no control of black pod disease and mistletoe

Communication Factors Associated with Dissemination of Technologies

An understanding of the processes leading to the adoption of new technologies by farmers is important to the planning and implementation of successful technology dissemination and adoption. Communication, defined as a means of exchanging messages, is an act of giving information and receiving a response. An analysis of communication is "who says what to whom and with what response" (MacDonald and Hearle, 1990)

Fliegel (1989) conceptualized communication processes in terms of the S-M-C-R model depicted below

Sender ——→ Message —→ Channel——→ Receiver

For purposes of explication, one can use the extension worker as a prime example of a **sender**, the source of communication. An extension worker should of course, rely on others for information to disseminate. The **message**, which is prepared by the extension worker, should be clear as to its purpose. Objectives should be specified, the content of the message should be relevant to the audience and directly linked to the intent or purpose of the communication. In addition, the treatment of the message must be such as to be intelligible to the intended audience. Preparation of a message that an audience can understand requires a considerable depth of understanding of the context of the message. Such depth of understanding ideally includes practical experience with the implementation of ideas involved in the message and also assumes considerable knowledge of how particular message elements fit into the aggregate agricultural production process of farmer clients.

According to Fliegel (1989), communication **channels** are the various methods available to any communicator in reaching an audience with a message. Written communication has obvious limitations in those Third World settings where literacy levels are low, but cannot be rejected out-of-hand in view of the considerable evidence that the print messages are read to non-literates in areas of low literacy (Deutschman, 1963).

Direct, face-to-face interaction via the spoken word is preferable in that it allows for questions to be raised and, in general, two-way communication to be easily and successfully accomplished. Face-to-face interaction is expensive, however, in that extension workers are commonly expected to serve rather large farmer audiences. It is for that reason that mass media methods, radio and more recently television, have come into increasingly wider use to reach audience with the spoken word. Visual means of communication include slides, films and television, plus the many variants of field demonstrations, which are probably the most effective method of communication available to extension personnel. To be effective, result demonstrations require the use of both visual and spoken communication and can easily benefit from the use of written material as well, a combination of methods, in other words, is the ideal (Fliegel, 1989). The **receiver** of the main interest here is the farmer.

Another element of an effective communication is the process of feedback, which makes the communication's process two-way rather than one-way only as shown i.e.

Receiver ⟵ Channel ⟵ Message ⟵ Sender

If the farmer is viewed as the receiver, then he or she must also be given the opportunity to function as sender, with the extension worker as receiver. In the absence of any reactions from the farmer (feedback), it is virtually impossible to gauge the appropriateness of the message content, or channel selection, for example, in the implementation of an information campaign.

Role of Agricultural Extension in Dissemination of Agricultural Technologies

One cannot rule out the role of extension system in the dissemination of information on known and feasible cocoa production technologies to farmers. According to Benor and Baxter (1984), sustained high level of agricultural production and incomes are not possible without agricultural extension services, supported by agricultural research, which is relevant to farmers' needs. Although there can be agricultural development with weak agricultural extension and research services, continued and widespread improvement requires professional, effective extension and research

In many developing countries, rural farm households and their agricultural land collectively represent the most important national resources. However, in too many countries, these human and natural resources remain largely untapped. Adequate and sustained agricultural research and extension are the most effective means of transferring these under-used resources into sustained agricultural development for economic growth. It may always be impossible to quantify the contribution of extension to agricultural development but there is little doubt that an effective extension contributes significantly and immensely to agricultural development. Effective investment in agricultural extension contributes directly to national wealth through increased agricultural production and enhanced national food security.

In addition, increasing the technical and managerial skills of farm households not only accelerates the adoption and use of improved technology but also increases the ability of farm household members to successfully compete for jobs off the farm when agricultural development occurs and few people are needed in direct agricultural production. Extension can contribute to agricultural development, through both technology transfer and human resources development, particularly among large members of small-scale men and women farmers of developing countries (Saville, 1965).

Maunder (1973) viewed extension as a system that assists farm people in improving farm methods and techniques, increases production efficiency and income, improves levels of living and lifts social and educational standard of rural people. FAO (1975) noted that agricultural extension is an informal service for training and influencing farmers to adopt improved practices in crop and livestock production, management, conservation and marketing.

Swanson (1984) observed that agricultural development implies a shift from traditional methods of production to new resource based methods of production that include new technological components such as new varieties, cultural practices, etc. As such, agricultural extension should take it as a role to teach farmers in management decision-making, leadership and organizational skills. Farmers can then better organize, operate and participate fully in cooperatives, credit societies and other support organizations. Farmers can also participate fully in the development of their local communities.

Changing Perceptions Concerning the Role of Agricultural Extension Services

In the early days, extension focused on how to get technological messages across. However, as the adoption rate of these messages by agricultural producers was often below expectations, extension services came to realize that it would be more effective to spend more time and energy involving its target groups in defining the message content and communication channels utilized in the decision-making process in general and tailoring its services to their needs. Extension services realized that such actors as researchers, policy-makers, agro-industries, commercial companies, extension agencies and farmers (and their organizations) are mutually interdependent.

Those actors involved potentially work synergically to support decision-making, problem solving and innovation in agriculture or a domain thereof. This is how the new concept of agricultural knowledge and information systems (AKIS) was born. It promises a comprehensive analysis of phenomena beyond the boundaries of conventional extension and a practical contribution in terms of knowledge management and policy (Roling, 1988)

Context of Extension Reform

Christopolos (2003) stated that extension policy in many countries tends to be institutionally monolithic, centrally directed and organized on the premise that public sector extension structures can effectively reach down to village level. Partly in reaction to this, 'reform' has been undertaken in the sense of wide-scale privatization of extension and removal of the state 'subsidy' that public sector involvement is thought to imply. Neither of these two basic models proved effective in providing services that small-scale farmers demand and find useful. In addition, neither reflected what extension means today

Extension is now broadly acknowledged to refer to a pluralistic array of institutions engaged in knowledge and information related to technological change. It is not restricted to the public sector, but the public sector remains, in many countries, a very significant sector. Extension that promotes technical change in agriculture must take careful account of the broader impacts of technological change on the rural folks. This is very different from extension's focus on the adoption of technologies by individual farmers

Approaches to Extension

Hakutangwi (1994) defined Extension Approach as the style of action within a system. It is more like a doctrine for the system, which informs, stimulates, and guides such aspects of the system as its structures, its leadership, its programs, its resources and its linkages. By approaches to extension, we understand the fundamental, conceptual and functional methods adopted to fulfill its aims

According to Vos and Krauss (2002), traditional extension approaches, which accompanied the Green Revolution, were characterized by technologies developed by researchers on research stations, top-down transfer of technology by researchers to extensionists, and from these to the farmers and blanket recommendations for large areas. The classical "top-down" view is that innovations are generated by scientists, passed on to extensionists, and transferred to farmers. Since the transfer of technology model of top-down dissemination was largely discarded as not being effective in the early 70s, efforts have been made to develop models of technology development and dissemination that would involve the intended beneficiaries of these processes

Hakutangwi (1994) distinguished three different umbrella approaches, namely

- Problem-solving approach, which puts the farmer and his constraints and abilities at center stage and attempts to mobilize the entire extension apparatus and the research system to service the farmer
- Production technology approach, which is also known as innovation-centered approach, aims to transfer to farmers, technology from outside their socioeconomic context. Extension actively promotes technical innovations and persuades farmers to adopt them.
- General agricultural extension approach with the main feature of improving the productivity and efficiency of the entire farming community by providing wide subject matter coverage. It deals with farm management, livestock, crop production, conservation, agro

forestry and horticulture. In this approach the extension system seeks to solve the farmers' problems.

The Training and Visit (T&V) extension system was introduced in many developing countries in the 1970s. It is an effective management model that enables efficient implementation of known extension principles. The approach is perceived basically as being top-down including the transfer of technology philosophy from research-extension-farmer. Top managers plan extension programs and regions and districts implement them. Arokoyo (1998) noted that for dissemination of research results both Ghana and Nigeria use the classical Training-and-Visit System (Nigeria), or modification of this approach (Ghana), within a unified extension service, which requires the extension agent who is directly in contact with farmers to deliver all messages.

Farming Systems Research (FSR) approach to extension, according to Hildebrand (1980), tries to systematically understand the complexity of the farming system through diagnosis-trial-experimentation-verification and extension. Farming Systems Research uses multi-disciplinary teams consisting of biological and social scientists. According to Christopolos (2003), options for "pro-poor extension" include an array of approaches, namely, direct targeting, strategies to enhance the benefits of growth, and addressing vulnerabilities and livelihood shocks. The transfer of technology view of extension has been superseded by participatory, community-based approaches, reflected in the currently fashionable approaches of Participatory Rural Appraisal (PRA), Farmer Participatory Research (FPR), or more generally, Participatory Learning Action (PLA).

The "strategic extension campaign" (SEC) methodology developed by FAO has been introduced in Africa, the Near East, Asia and Latin America. This methodology emphasizes the importance of people's participation (i.e., intended beneficiaries such as field extension workers and small farmers) in strategic planning, systematic management and field implementation of agricultural extension and training programs. Its extension strategies and messages are specifically developed and tailored based on the results of a participatory problem identification and needs assessment. The SEC technology transfer and application approach is needs based, demand-driven and has a problem-solving orientation.

The SEC program follows a systems-approach, which starts with farmers' Knowledge, Attitude and Practice (KAP) survey whose results are used as planning inputs and benchmark/baseline for summative evaluation purposes. In addition, a series of practical and participatory approach workshops are conducted to train extension personnel, subject-matter specialists, trainers and farmer leaders together on the skills of extension program planning, strategy development, message design and positioning, multi-media materials development, pretesting and production as well as management planning, implementation, monitoring, and evaluation. The strength of this approach is in orienting and training relevant extension personnel to apply a systematic, rational, pragmatic approach to planning, implementing, managing, monitoring and evaluating regular/routine programs of an agricultural extension service.

Development of Agricultural Extension in Ghana

Agricultural extension started in Ghana at Aburi Botanical Gardens where few school leavers received training and went out to teach farmers in Akwapim on improved production technology of some important crops, with emphasis on cocoa (Ministry of Agriculture, 1991). A number of re-organizations occurred within extension services in the past, which led to the creation of parallel extension departments. The farmer was confronted with different extension agents who talked on different technical content and approaches

In 1950, the Ministry of Agriculture established the Cocoa Division to disseminate information on improved methods of cocoa cultivation to farmers. The Division became the Cocoa Services Division (CSD) of the Ghana Cocoa Board in 1972 that was the extension wing of the coca industry. The Division assisted farmers directly on their farms and provided extension training. The extension training of farmers in improved practices was done at the 17 farmer hostels established in the coca growing areas. Experimental farms known as "block plantings" were also established to facilitate demonstration exercises. COCOBOB stopped this system of training due to financial constraints and poor patronage. Farmers found the two-week confinement from their farms and families very inconvenient. The Division was restructured in 1985 under the Cocoa Rehabilitation Program (CRP), which was to promote improved production technology among farmers. The new role was changed to concentrate on providing extension education and inputs to farmers. The cocoa growing area of the country was divided into 1,465 extension units. An Extension Assistant, who lived within the farming community, manned a unit.

and delivered the necessary advice to farmers. The extension strategies included improved work programming and supervision, direct contact with farmers, regular and frequent in-service training. Other strategies were forging two-way links with the Cocoa Research Institute and the establishment of a field-oriented extension monitoring and evaluation system.

Extension Field Assistants (EFA) worked based on a four-week work cycle. They divided their areas of control into sixteen sub-units, each with approximately equal number of cocoa farmers. The extension Assistants visited farmers in each sub-unit on one specific day in the four-week cycle (e.g., on the second Tuesday of every month, which to the farmers would be known as every fourth Tuesday). The schedule of visits established took into account local market and taboo days. For most of the weeks, one day was left unscheduled so that any missed visit could be made up. In addition to these scheduled and unscheduled visits, one day in each four-week cycle was for in-service training of Extension.

Once the program of the Extension Field Assistant had been established, it was made known to all Farmers in his/her jurisdiction and remained unchanged. The program ensured that each extension worker systematically covered all farmers and locations in his area. Farmers knew when the extension worker was to visit them and supervision of the agent's work became easy. There was adequate flexibility to make up for missed visits and the extension assistant received frequent guidance and training. Extension Field Assistants did not sell or distribute farm inputs, though they involved themselves in monitoring the demand and supply of inputs.

At the Regional and Headquarters levels, technical specialists supported extension field activities and in-service training and had close coordination with Cocoa Research Institute and other farmer support services. These specialists, along with the Regional Cocoa Officers, were the main trainers of the Extension Field Assistant and Senior Technical Assistants in their four-weekly in-service training and review sessions.

Adoption of Agricultural Technologies Introduction

This section examines the history, influence and impacts of innovation diffusion theory on the Extension Service. It reviews some of the major developments in the literature related to the theory, examines its criticisms and discusses the implications for Extension.

History

A seemingly small event occurred in 1928 that provided the basis for a theory that has influenced how the Extension Service has conducted its programs for the past six decades. During that year, the Iowa State Agricultural Experiment Station released hybrid corn to farmers. With its yield advantages over traditional corn varieties and promotion by the Extension Service and commercial seed companies, the seed was adopted briskly. Between 1933 and 1939, the number of acres planted to hybrid corn increased from hundreds to thousands. By 1940, it had been adopted by most Iowa corn growers (Ruttan, 1996). In 1941, Bryce Ryan, a professor of rural sociology at Iowa State University, received funding to examine the spread of hybrid corn. He presumed that a better understanding of the hybrid corn diffusion process would help disseminate other innovations developed by the station (Ruttan, 1996). The resulting classic study by Ryan and Gross (1943) revealed the following:

- The adoption process began with a small number of farmers who adopted hybrid corn soon after it was released. From these farmers, the innovation diffused to other farmers
- The most influential source of information on this innovation was neighbors. When farmers saw and interacted with farmers who had adopted hybrid corn, they adopted it too

These findings implied that if innovative farmers were targeted to adopt innovations, other farmers would soon follow, speeding up the adoption of new agricultural practices. The idea was simple and compelling and it provided the basis for a model of agricultural development that the Extension Service continues to use today. The Ryan and Gross study was followed quickly by studies that examined various aspects of the innovation diffusion process. These studies and their subsequent improvements in theory are closely associated with the agriculture revolution in the United States. During this period, agriculture was undergoing rapid change to a system that relied on mechanization and synthetic inputs. From the 1940s through the 1960s, researchers plotted mathematical curves representing the adoption of agricultural innovations, developed categories of adopters, catalogued the characteristics of adopters and innovations and examined the influence of farmer interaction on the adoption process

Adoption Curves

Ryan and Gross (1943) plotted the number of farmers adopting hybrid corn based on the year farmers adopted it. The data revealed a normal curve. Lionberger (1960) plotted the same type of data on a cumulative basis and revealed an S or growth curve. Both curves indicated that with adoption, which is measured at one point in time, there is a slow growth in the use of a new technology, followed by a more rapid increase and then a slowing down as the cumulative proportion of adoption approaches its maximum.

Categories of Adopters

Researchers have often assigned titles to individuals based on their adoption behavior. The best-known scheme is from Rogers (1958). Since the adoption of an agricultural innovation followed a normal curve, he developed classifications of adopters by calculating the mean for the curve and then, by adding or subtracting the standard deviation, divided the curve into five segments. The segments were assigned these categories: Innovators, Early Adopters, Early Majority, Late Majority, and Laggards (Figure 1).

The classic adoption curve indicates a small number of individuals adopting the innovation early (left tail). They are called innovators. This group forms about 2.5 per cent. If the new idea survives for an appreciable length of time and is accepted by more than the first few, one can identify a second category of farmers, here called early adopters. They are also about 13.5 per cent. Then, if the idea continues to spread, the bulk of farmers who ultimately accept the new idea can be classified as early majority (34%) and late majority (also 34%), depending on the time (early or late) at which they make the decision to accept. Those adopting last form the right tail of the curve (after Rogers, 1958). They are conventionally called laggards. This last group is conservative and always wants to play it safe. They constitute 16 per cent.

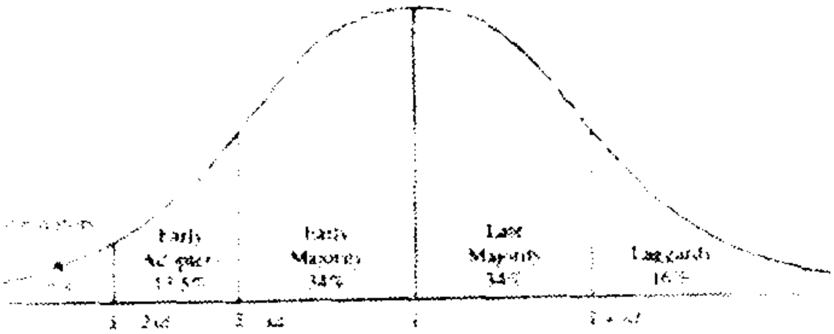

Figure 1. The Adoption Curve

Source: Rogers, 1958.

Characteristics of Adopters

The literature describes farmers who adopt an innovation early as being different from other farmers. Innovators are younger (Lionberger, 1960), more cosmopolitan (Coleman, 1957), have higher incomes than later adopters (Lionberger, 1960), and have the largest operations of all adopter categories (Coleman, 1957). There is a great deal of evidence (Rogers, 1983) to show that innovators have more land and other physical resources at their disposal. In addition, adopter categories differ in their source of information on innovations, with innovators relying on a range of information sources including primary sources. Conversely, laggards rank at the opposite extreme on each characteristic. The other adopter categories rank between the two

- Relative advantage: The degree to which an innovation is perceived as better than the idea it supersedes. The acceptance of an innovation is thus in relation to economic gains, social prestige factors, satisfaction and convenience associated with it. Adams (1982) observed that sometimes, lower cost and subsidies enhance the relative advantage of innovation.
- Compatibility: The degree to which an innovation is perceived as consistent with existing farmers values, experiences and needs of potential adopters. Management objectives, level of technology and farm development also affects compatibility. Farm size, availability of equipment and machinery determine the compatibility of an innovation.
- Complexity: The degree to which an innovation is perceived as difficult to understand and use. Most members of social system readily understand some innovations; others are more complicated and will be adopted more slowly. Perhaps, the more complex an innovation is the more difficult for farmers to adopt.
- Trialability: The degree to which an innovation may be experimented with occasionally. A farmer will be more inclined to adopt an innovation that he has tried first on a small scale on his own farm and that proved to work better than an innovation he had to adopt immediately on a large scale, which involves great risk.
- Observability: The degree to which the results of an innovation are visible to others. Farmers incline to adopt an innovation after seeing its results than when results are not easily seen.

In addition to the perceived attributes of an innovation, Rogers mentioned that the following variables affect an innovation's rate of adoption

- The type of innovation-decision
- The nature of communication channels diffusing the innovation at various stages in the innovation-decision process
- The nature of the social system and
- The extent of change agents' promotional efforts in the diffusing the innovation

The type of innovation-decision is related to an innovation's rate of adoption. We generally expect that innovations requiring an individual-decision will be adopted more rapidly than when an innovation is adopted by an organization. The more persons involved in making an innovation-decision, the slower the rate of adoption. If so, one route to speeding the rate of adoption is to attempt to alter the unit of decision so that fewer individuals are involved.

The communication channels used to diffuse an innovation also may have an influence on the innovation's rate of adoption. For example, if interpersonal channels must be used to create awareness-knowledge, as frequently occurs among later adopters, the rate of adoption will be slowed. The attributes of innovation and the communication channels probably interact to yield a slower or faster rate of adoption. For example, Petrini (1968) found differences in communication-channel use on the basis of the perceived complexity of innovations among Swedish farmers. Mass media channels, such as agricultural magazines, were satisfactory for less complex innovations but interpersonal contact with extension agents was more important for innovations that were perceived by farmers as more complex. And if an appropriate channel was used, such as mass media channels, for complex ideas, a slower rate of adoption resulted. Especially important are the norms of the system and the degree to which communication network structure displays a high degree of interconnectedness.

The relationship between rate of adoption and change agent's efforts, however, is not direct and linear. There is a greater pay-off from a given amount of change agent activity at certain stages in an innovation's diffusion. Stone (1952) and Petrini (1968) showed that the greatest response to change agent effort occurs when opinion leaders are adopting, which usually occurs somewhere between three and 16 per cent adoption in most systems.

Literature reviewed showed that farmers tend to selectively adopt components of a package in a stepwise fashion based on various factors. It is conceivable therefore that one would find that between non-adoption and full adoption, there are categories of adoption in a continuum.

Stages of the Adoption Process

There are several views about what the process of adoption entails. Now there is a relatively wide acceptance of the proposition that people go through a minimum of five stages while adopting innovations (Beal, Rogers, and Bohlen 1957, Maunders, 1973, and Rogers, 1983) developed a sequence of stages to describe the adoption process. These stages are awareness, interest, evaluation, trials and adoption. Awareness stage involves the individual learning of the existence of an innovation. At this sage, he has little knowledge about it and depending upon an individual's felt need he/she may want to go and find out more about the innovation. Interest refers to when the individual seeks more information about the innovation from sale agents, professional change agents, mass media, friends and users of the innovation. Information is sought on why and how the innovation works, how much it costs, how it compares with other ideas, which perform the same function. Evaluation involves mental assessment of the advantages and disadvantages of using the innovation in his own circumstances. At this stage, he considers his resources and management ability and decides whether to adopt the idea or not. If he felt it would maximize his goals and objectives, he makes the decision to give the idea a trial. In the trial stage, the innovator tests the innovation on a small scale in his situation.

The change agent, who may demonstrate how the innovation works, and then assist the individual to try, may assist him in the trial. Adoption is the stage at when the individual decides that the new idea, product, or practice is good enough for continuous use on a full-scale basis. In practice, these stages are not necessarily a rigid pattern or exclusive category with no overlap. Thus, one cannot identify the beginning of one stage from the other. What the stages do, however, is to offer a way of describing a relatively continuous sequence of actions, events and influences, that intervene between initial knowledge about an innovation and the actual adoption or rejection (Lionberger, 1968).

Interaction among Farmers

Ryan and Gross (1943) documented the importance of interaction among farmers. "The very fact of acceptance by one or more farmers offers new stimulus to the remaining ones. The decision to adopt is a product of the influence and incentives brought to bear." Havens and Rogers (1961) identified what they termed the "interaction effect." This is the process through which individuals who have adopted an innovation influence those who have not. They contended this is the major factor influencing adoption of innovations.

Supports of the Adoption Theory

Portions of the theory are still viable, while others are problematic. The segments of the adoption literature that have maintained viability over the years are related to the characteristics of innovations, the stages of the adoption process and the effect of interaction of farmers on adoption. One area of research by social scientists involved in more recent agricultural development has focused on the decision-making process of farmers. This literature generally is consistent with the innovation diffusion literature as it relates to the characteristics of innovations and to the stages of the adoption process. For example, Vanclay's (1992) work, which identified barriers to adoption of innovations, is consistent with the work by Bohlen (1961) and Brandner and Straus (1959). Further, Gladwin and Murtaugh (1980) and Gladwin (1980) identify stages of farmer decision-making that are largely consistent with Beal, Rogers and Bohlen (1957) stages of the adoption process discussed earlier. Stephenson (1980) in work related to the adoption of technology by fishermen; and Stephenson (2002) in documenting the adoption of conservation practices by horse farm owners. The most controversial area has been the theory's focus on the most innovative farmers and the undesirable consequences of using this approach.

Criticism of the Adoption Theory

Criticisms of the theory began to appear in the late 1960s, when it was applied to international development. According to Ruttan (1996), initial criticism of the theory focused on methodological problems with the research, but interest in the theory declined as it began to be viewed as a source of inequity among farmers. Goss (1979) observed that the application of innovation diffusion theory in developing countries had undesirable consequences. These problems stemmed from the following

- It is assumed that benefits resulting from the adoption of innovations spread and become homogeneous. But experience from Latin America showed the gap in inequities actually widened.
- Aggregate statistics for development projects may show improvement in elements like production, but commonly the farmers most in need of help received little benefit.
- Non-adopters are affected by the diffusion of innovations process because larger farmers increase production as a result of adopting an innovation, resulting in a decrease in prices received by all farmers

Other criticism of innovation diffusion theory came from business and marketing perspectives. Downs and Mohr (1976) severely criticized the theory, contending it needs to be organized around attributes of both the innovations and the organizations adopting them. They tossed aside the notion of static categories of adopters, maintaining that anyone can be an innovator if innovations are matched with organizations targeted for adoption. Brown (1981), offering his market and infrastructure approach, points out that implementation of projects using innovation diffusion theory require focusing monetary and personnel resources on a small number of people, the category traditionally considered innovators. He recommends using marketing techniques to target appropriate innovations to specific segments of farmers.

Rogers (1983) acknowledges criticisms of the theory, noting that the absence of critical viewpoints in the early development of the theory may have been a weakness in the long run. Had adjustments been made earlier through critique and debate, perhaps some of the current problems with the theory would have been avoided. Criticisms compiled in the most recent edition (1995) include:

A Pro-Innovation Bias

There is the implication that an innovation should be diffused and adopted by all farmers.

The act of innovating is considered positive and the act of rejecting an innovation is considered negative. Remember the categories of adopters. Innovators versus Laggards

Individual-Blame Bias

The development agency is not blamed for its lack of response to the needs of farmers. Rather, the individuals who do not adopt the innovation are blamed for their lack of response.

Issue of Equality

The negative impacts of the theory are not considered. What are the consequences in terms of unemployment, migration of rural people, and equitable distribution of incomes? Will the innovation widen or narrow socioeconomic gaps?

Bias in Favor of Larger and Wealthier Farmers

"Development agencies tend to provide assistance especially to their innovative, wealthy, educated and information-seeking clients. Following this progressive, or ('easy to convince') diffusion strategy leads to a lower degree of equality. For example, more progressive farmers are eager for new ideas and have the economic means to adopt; they can also more easily obtain credit if they need it. Because they have larger farms, the direct effect of their adoption on total agricultural production is also greater" (Rogers, 1995: 128-129). Consequently, the rich get richer and poor get poorer.

Changes to Make Application of Adoption Theory Consistent with Current Knowledge

Based upon the extensive criticism of the negative consequences of innovation diffusion theory, it is time to reconsider how we use it in agricultural outreach. Most negative consequences of the theory ultimately lead to problems with economic inequalities among farmers. These inequalities and the resulting loss of farms will continue unless the Extension Service makes a special effort to prevent it. Consider the following as noted by Stephenson (2002).

Tailor communications to all categories of farmers to promote awareness and information (Rogers, 1995). This involves putting some thought into segmenting the farm population by type and size or other characteristics and directing programs specifically to these segments. This segmentation may also be based on who needs help. As previously mentioned, Brown's (1981) approach to innovation diffusion includes utilizing methods from marketing to enhance adoption. The development of small farm programs by Extension at the national and state levels is an example of a positive step

Involving them in developing technology and practices that are appropriate for their farm and financial scale may enhance the success of less financially advantaged farms. The formation of organizations such as cooperatives to enhance access to financial resources continues to be a good strategy (Rogers, 1995). Participation in developing technology is a key concept from international agriculture development that applies to the industrial world as well (Dlott, Altieri, & Masumoto, 1994; Wuest, McCool, Miller, & Veseth, 1999). In addition, Brown (1981) insists that change programs must have a financial support infrastructure for farmers in order to be successful.

Shifting our focus from working with wealthy innovative farmers to working with less financially advantaged farmers may require some fundamental changes. These farmers ". . . tend to place less credibility in professional change agents and they seldom actively search for information from them . . . "(Rogers, 1995, p. 438). This is a tougher audience to access and work with, perhaps because of a long history of neglect. They are also likely the farmers who would benefit the greatest. Greater risk protection, for both farmers and Extension staff, will encourage greater activity for and by this audience. Financial risk protection for farmers, particularly small farmers, will enhance their willingness to take risks. Extension staff may increase their willingness to risk a programmatic failure if administrators protect them from performance criticism.

Our audience is changing. Who do we represent nowadays? Farmers? Farm workers? Farm communities? Consumers? What are the impacts of our efforts on each of these groups? The Extension Service has a long and successful engagement with people in rural areas. Our high client participation has been a means to this success. At the same time, the Extension Service is credited with having an elite bias (Rogers, 1988). We can change this by realizing that our methods can influence, which farmers succeed and which farmers are excluded from success.

Adoption of Cocoa Production Technologies

The attempt here is to review representative works on cocoa production technology adoption. According to Adebgola (1979) technological changes observed among Nigerian cocoa farmers included new planting procedures in the establishment of new farms, increased use of pesticides in the maintenance of their farms and the adoption of the procedure of digging soil profile pits for examination before putting their farms to cocoa.

The Committee Report (1995) indicated that, for three consecutive years (1990/91-1992/93) only one-third of the farmers interviewed weeded their farms adequately (i.e. 3-4 times as recommended). It noted that more than half the number of farmers interviewed did not spray adequately against capsid damage (three to four times per annum as recommended). This was more pronounced in Volta Region where over 60% of farmers did not spray at all. The report also noted that many farmers did not apply the recommended chemical control measures against black pod disease. Of the 12 recommended technologies, Asante-Mensah (1988) mentioned that over two-thirds of farmers adopted two, namely, cultural control of black pod disease and mid-crop harvesting. Two other practices, mistletoe and swollen shoot disease control, received medium adoption. Dankwa (2001) mentioned that responses from farmers indicated 100% rate of adoption for brushing of cocoa farms and removal of unwanted basal chupons. Other technologies with high adoption rates were harvesting of ripe cocoa pods and removal of mistletoes. Technologies with low adoption rates were fungicidal spraying, pegging and line planting. In general, the practices that required major capital outlay and were complex had low adoption rates, e.g. fungicidal spraying.

Majority of farmers indicated that income from farms; price of farm inputs and cost of labor influenced their adoption. Majority of farmers also indicated that they perceived complexity of technologies as the least factor that influenced their adoption of cocoa technologies. The overall level of adoption of cocoa technologies in Ashanti Region was generally high. Each district also had a high mean level of adoption of the technologies studied. The probable reasons were the long working experience of the cocoa farmers and their working contact with the extension workers.

The results of a study by Asante (2002), categorized the recommended husbandry practices into three levels based on percentage awareness and adoption. The levels were high (above 80 %), moderate (50-70%), and low (below 50 %). The high level practices were: weeding, capsid control, and mistletoe removal and shade control. Others were pruning and harvesting. Moderate practices included: Black pod disease control and hybrid seedling nursery. Husbandry practices, which showed low awareness and adoption, were line planting and fertilizer application. The frequency of adoption of these practices followed the same trend as percentage awareness and adoption. The determinants of high-level management technology were relative advantage, input availability, credit, education, yield per hectare, acquisition of motor sprayer and extension contact.

Background Characteristics of Farmers and Adoption Behavior

Background characteristics, such as age, sex, education, experience and household size may influence farmers' adoption behavior in a number of ways as reviewed below:

Age

A farmer's age may influence adoption in one of several ways. Older farmers may have more experience, resources, or authority that would allow them more possibilities for trying a new technology. On the other hand, it may be that younger farmers are more likely to adopt a new technology because they have had more schooling than the older generation (CIMMYT Economic Program (1993).

Asante-Mensah (1988) mentioned that over 70 per cent of respondent cocoa farmers were over 50 years old while only 7.3 per cent were under 40 years old. His findings showed that age had no significant relationship with overall adoption of recommended practices. There was also no significant relationship between age and the adoption of physically strenuous practices.

Dankwa (2001) reported that age positively correlated with the adoption levels. The age of cocoa farmers ranged from 29 to 90 with a mean and mode of 54 years and 45 years, respectively. Farmers below 40 years were 14.4 per cent of the total respondents. Asante (2002) mentioned that the average of cocoa farmers was 55 years. About 38 per cent of the sampled farmers were aged between 30 and 50 years. The majority was within the 50 to 70 years group. More than 30 per cent of the farmers were older than 60 years.

Sex

CIMMYT Economics Program (1993) observed that if results in adoption studies show a significant difference between men and women farmers, it may be that recommendations examined are less appropriate for the crops grown or crop management practiced by women. It may also be that women farmers are less likely to command the resources (such as land, credit, or information) to take full advantage of the technology. In such cases, conclusions might be to place more emphasis on technology development that is appropriate to the resources of women, or to address policy changes that might make services such as credit or extension more available to women farmers.

Addo (1972) reported that out of 4,000 cocoa farmers interviewed, the ratio was 9:1 males to females. Okali (1983) also found that more males were involved in cocoa farming than females. The study further indicated that cocoa farming tended to be more of a male business while food crop farming was more of a woman's one. Asante-Mensah (1988) mentioned that males constituted by far, the greater proportion of respondents, representing 82.8 per cent of the sample. Sex was significantly associated with adoption of recommended practices. Male farmers tended to be higher adopters than female farmers. He found significant association established between sex of farmers and adoption of physically strenuous practices like mistletoe control.

Dankwa (2001) reported that majority (84.4%) of the cocoa farmers interviewed in Ashanti Region were males and 15.6% were females. According to him, correlation between sex and adoption levels of cocoa technologies was significant but negative at .05 alpha levels.

Education

Many adoption studies show some relationships between adoption and the educational level of the farmer. Gordon (1976) observed that education, to some extent, determines the type of tasks farmers can perform. Education also determines the level of participation and how to relate new technologies and prices of inputs to farming operations

If a particular technology finds its way predominantly to farmers with a certain level of education, then several options should be considered. One is to try to simplify the technology (or develop alternatives) so that it is more accessible. Another option is to concentrate extension resources on farmers with less education and to train them in the use of the new practice. And a third option is to use this result in making a case for more investment in extension services, training, or rural schools to accelerate the use of agricultural technology, which is becoming ever more complex (CIMMYT Economics Program 1993)

In Ghana, Asante-Mensah (1988) found no significant association between educational status and overall adoption of recommended practices in Eastern and Brong Ahafo Regions. According to Asante (2002), about 53 per cent of cocoa farmers in Ashanti Region had no formal education. The rest had three to 14 years of formal education. The mean number of years of education was 3.8. Dankwa (2001) found out that 48.8 per cent of cocoa farmers interviewed in Ashanti Region had no formal education while 49.4 per cent had certificates. Only 1.3 per cent and 0.6 per cent of respondents possessed diploma and Bachelor degrees respectively. Furthermore, he found out that the correlation between the level of education of cocoa farmers and adoption level was significant at .05 alpha levels

Experience

Asante (2002) observed that farmers' working experience ranged from three to sixty-five (65) years. The mean and mode were 23 and 15 years respectively. Only five per cent of the farmers had less than 10 years working experience. Experience may indicate management level in the sense that more experienced farmers are more likely to understand that the greatest economic benefits of new technologies accrue to early adopters. The longer the time a farmer spends carrying out a certain practice, the more accustomed he becomes to doing it that way. A farmer's methods and practices develop more into habits or set patterns of farming behavior. Such fixed farming behavior then poses a barrier to change. Recommended practices would be more highly adopted by farmers who have farmed for a shorter time than those who have farmed for a longer time (Asante-Mensah, 1988). Contrary to this belief, he observed that no significant relationship was found between the number of years spent in cocoa farming and overall adoption of recommended practices among farmers.

Household Size

According to Asante-Mensah (1988), the majority of respondents (60%) had medium-sizes households with 7-15 members. Just over 20 per cent had small households. Respondents with large or very large households made up the remaining 18 per cent. On adoption, he noted that household size had no significant association with adoption of recommended practices. The fact that a farmer had a large household was not sufficiently strong a factor to lead to an increase in adoption level. With low profits from the cocoa farm, working members of the household would engage themselves in other enterprises in order to support them and may therefore not spend most of their time working on the cocoa farm.

Okali (1983) noted that wives and offspring were the main source of permanent labor force on cocoa farms. In a labor-intensive enterprise as cocoa farming, a larger household size would seem to be an advantage. Household size could exhibit a positive relationship with overall adoption of recommended practices since most of the practices are labor demanding. However, Barker (1981) observed no significant relationship between adoption and number of dependants

Farm Resources and Adoption of Technologies by Farmers

An analysis of farm resources provides feedback to research for refining technologies to make them more widely available. Farm resources like farm size, credit, labor, equipment and land tenure, yield as well as markets and prices of produce included in the study may make it easier for a farmer to change his or her practices

Farm size

Ministry of Agriculture (1972) noted that the average size of cocoa farms per farmer in Ghana was 4.9 hectares. While farmers in Ashanti had the largest average of 8.9 hectares, those in the Volta region had the smallest of 2.1 hectares. Gyamfi and Owusu (1979) observed that in Dunkwa district, farm sizes were small and sizes of 0.8 hectare were not uncommon. Farmers owned four or five small farms in several places in the district since farmlands were not obtained in contiguous blocks. However, some farmers owned about 2.5 to 4.1 hectares of cocoa farm in one block of land in the district.

Asante (2002) noted that farm size of cocoa in Ashanti ranged from 0.5 hectares to 64.6 hectares. The mean farm size was five hectares and the mode was two hectares. Asante-Mensah (1988) noted that 52.2 per cent of respondent cocoa farmers from Eastern and Brong Ahafo Regions had farms of up to eight hectares. Only 15.6 per cent had farms of over 20 hectares.

Rogers (1995) stated that adoption is more responsive to farm size at the innovator stage and the effect of farm size on adoption generally diminishes as diffusion increases. However, according Asante-Mensah (1988), farm size did not appear to influence the overall adoption of recommended practices since there was no significant relationship between size of respondents' farms and the level of adoption. This inference was supported by the close percentage distributions of the low, medium and high adopters over the size of farms.

It is often assumed that large-scale farmers will be more likely to adopt technology, especially if the innovation requires extra cash investment. It may be that a certain threshold farm size is necessary before the investment in technology is worthwhile. Or it may be that on large farms different management practices e.g. mechanization is used, making a recommendation more appropriate for them. Farm size may be related to access to information or credit that would facilitate the adoption of a recommendation (CIMMYT Economics Program 1993).

Weil (1970) found in Africa that adopters of ox cultivation cropped larger areas and operated significantly larger farms than those using hand cultivation. Several studies reviewed by Binswanger (1978) found similar strong positive relationship between farm size and adoption of tractor power in South Asia. Other empirical studies showed that inadequate farm size also impedes an efficient use and adoption of certain types of irrigation equipment such as pumps and tube wells (Dobbs and Foster, 1972; and Gafsi and Roe, 1979). Parthasarathy and Prasad (1978) found a significant positive relationship between farm size and High Yielding Variety (HYV) seed adoption about seven years after HYV introduction. Since HYV technology is seemingly scale neutral, the result may appear to be at variance with economic intuition. However, seemingly neutral technologies such as HYV may entail significant setup costs in terms of learning, locating and developing markets as well as for training hired labor.

While many studies indicate no significance difference in chemical input use per hectare between farms of different size, (Lipton, 1978; Singh 1979), others indicate a positive relationship between the amount of fertilizer applied per hectare of fertilized land and farm size. Clawson (1978) reported similar findings. Rogers (1983), in a summary of studies on innovation, generalized that there is a positive relationship between larger sized units and innovativeness (i.e. larger farm owners are more likely to adopt innovation than smaller farm owners. Rogers (1995) further observed that adoption is more responsive to farm size at the innovator stage and the effect of farm size in adoption generally diminishes as diffusion increases.

However, some empirical studies find negative relationships between intensity of use of modern inputs and farm size. Van der Veen (1975) suggested three possible explanations for this observed phenomenon. First, small farmers may farm land more intensively to meet subsistence needs; second, small farms may irrigate more efficiently; and third, small farms use relatively more low-cost family labor.

Wiltshire (1975) found no significant relationship between farm size and adoption among coffee farmers in Trinidad. Barker (1981) also reported no significant relationship between farm size and adoption and attributed this to the fact that none of the innovations studied needed a great capital outlay and therefore farm size was not reflected in the farmers' adoption behavior. Since the influence of these factors varies in different areas over time, so does the relationship between landholding size and adoption behavior.

Labor

Technologies have different characteristics; some reduce the amount of labor required for growing a crop, while others significantly increase it. For example, bullock cultivation is labor saving, labor shortage might encourage its adoption. On the other hand, higher yielding variety technology generally requires more labor inputs so labor shortages may prevent adoption. Moreover, new technologies may increase the seasonal demand of labor so that adoption is less attractive for those with limited family labor or those operating in areas with less access to labor markets (CIMMYT Economics Program, 1993).

In Ghana, as little capital equipment is used in agricultural production, the supply and mode of the agricultural labor force is a key determinant of the volume of agricultural production. According to Andreae (1980), cocoa cultivation tends to be labor intensive in comparison with coffee, rubber, and oil palm as a monocrop Labor expenditure is often the largest component for the cost of cocoa production

The Committee Report (1995) noted that farm labor was found to be one of the most important limiting factors in cocoa production Three categories of labor were identified. namely. family. hired and caretaker Family labor was found to be scanty and hired labor expensive. Hired labor was generally available but difficult to come by in areas where farmers of other crops and mining companies paid higher wages than those offered by cocoa farmers

Ghana Cocoa Sector Development Strategy Report (1998) also noted that availability of more rewarding opportunities for laborers e g in mining. reduced supply of labor. This affected the price of hired labor for cocoa farming. For example, the price of labor per day for weeding cocoa farms was generally lower than the price of labor per day in the mining areas or areas with timber operations

Dankwa (2001) noted that over 57 per cent of cocoa farmers had difficulty in obtaining labor to work on their farms. He stated that 25.6 per cent of farmers used family labor while 20 per cent of farmers hired labor Communal labor formed about nine per cent of labor used by farmers. Family labor was the most effective, by farmers' perception, followed by hired labor The least effective source of labor was communal labor. He further showed that 45 per cent of cocoa farmers employed caretakers in Ashanti Region.

Ministry of Finance Report (1998), mentioned that caretakers are useful to maintain cocoa farms. particularly for aged and absentee farmers However, some farmers perceived care taking labor as being poor in the management of cocoa farms, resulting in high losses due to diseases and pests. On the relationship between labor and adoption of technologies by cocoa farmers. Dankwa (2001) noted that effectiveness of family, communal, hired and caretaker labor, positively correlated with adoption level, though not significant statistically (0.05 level)

Credit

Access to capital in the form of either accumulated savings or capital markets is necessary in financing the adoption of many agricultural technologies. If a recommendation implies a significant cash investment for farmers, an efficient credit program may facilitate its adoption. If the majority of adopters use credit to acquire the technology, this is a strong indication of credit's role in diffusing the technology. Similarly, many farmers who do not adopt may complain of lack of cash or credit as the principal factor limiting their adoption (CIMMYT Economics program 1993)

Quadoo (1957) elucidated the problem of availability of cash for farming, farmer indebtedness, high rates of interest and the pledging of farms for cash in times of need. La Anyane (1972) mentioned "cocoa farmers have small holdings and small incomes and are chronically in need of credit". Moreover, Cocoa Services Division (1985) reported that low cash supply and lack of credit contributed to farmers' inability to purchase insecticides and spraying machines for the Cocoa Rehabilitation Program

Okali (1983) remarked that "apart from the Government's Eastern and Ashanti Cocoa Rehabilitation Programs, (through which farmers with declining farms received assistance in replanting), there have been few attempts to provide credit directly to encourage farm expansion. The main source of capital for production derives from the farmers themselves".

The Committee Report (1995) stated that of the farmers encountered; only 22% obtained credit from Banks within three years. Eight per cent obtained credit from other sources while the remaining 70% had no credit at all. The Report further noted that the essence of credit to farmers was to enable them to properly maintain their farms in anticipation of better returns. In the absence of credit, most farmers were compelled, especially during the period of closure of the cocoa-purchasing season, to either sell their harvest at a very low price or pledge their farms. The non-availability of credit also encouraged smuggling, particularly in the border areas.

Asante (2002) reported that the level of provision of credit to cocoa farmers was very low. Only 12 per cent of cocoa farmers received credit in cash or inputs. This means that most farmers depend on their own resources to maintain their farms, as noted by Ampofo (1990). Nonetheless, of respondents interviewed by Asante-Mensah (1988), majority (62.2 per cent) acquired loans for their cocoa farm operations while 30.6 per cent took loans for their living expenses especially during the cocoa off-season.

Lipton (1978) noted that differential access to capital is often a factor affecting differential rates of adoption. That is, in particular, the case with indivisible technology, such as tractors or other machinery that requires a large initial capital. On the other hand, many argue that lack of credit is not a crucial factor inhibiting adoption of innovations that are scale neutral. For example, profitability of higher yielding variety adoption will induce even small farms to mobilize small cash requirements for necessary inputs. Von

Pischke (1978) similarly, questions the assertions presenting credit availability as a precondition for adoption

A number of studies, however, found that lack of credit is an important factor limiting adoption of high yielding variety technology where fixed pecuniary costs are not large. For instance, many studies found that a majority of small farmers reported shortage of funds as a major constraint on adoption of divisible technology such as fertilizer use (Wills, 1972)

Equipment and Machinery

Farmers' ownership of equipment or machinery may influence their ability to adopt. The lack of spraying machines, cutlasses and pruners has been cited as some of the factors that led to decline in production. Availability of such inputs will have a direct relationship with adoption of recommended practices since a lack of these inputs will be a constraint to adoption (World Bank, 1983)

Farmers who use tractors or draft animals can be more flexible in changing their tillage practice than farmers who rent or borrow equipment. If a recommendation involves a new type of machinery, the degree of adoption may depend on the number of farmers who are able to acquire the equipment and whether or not an effective rental market develops (CIMMYT Economics Program, 1993). The adoption of farm mechanization alleviates labor bottlenecks. For example, tractor power can make possible more timely farming operations, allow increased production and reduce labor demand. It can also ensure double and multiple cropping as confirmed by Spenser and Byerlee (1976) in Sierra Leone.

Land Tenure

Several studies argue that tenure arrangements may play an important role in the adoption decision. Views, however, are not unanimous; and the subject is of considerable controversy. For example, Spore (2000) noted that guaranteed land rights encourage greater investment in technology and its adoption, which in turn leads to higher yields. They also make it easier to obtain credit. However, Scandizzo (1979) concluded that property owners would be reluctant to adopt land-augmenting innovations if interest earnings and price margins are high (owning to the fact that landlords market their tenant's output).

In Ghana, cocoa land is held mainly on freehold by landowners consisting of individual families and clans through inheritance from clans or family and by land purchase (Ministry of Finance Report, 1998). On tenure arrangement, Asante-Mensah (1988) noted that cocoa farmers owned their land through self-acquisition, through citizens' right to land, through purchase of land for development into a cocoa farm, through purchase of an established farm, through inheritance or as a gift. Asante (2002) showed that 78 per cent of respondents were owner-occupiers and 22 per cent were tenants.

An issue that is much debated in the adoption literature is the degree to which land tenure affects a farmer's ability to adopt. For example, Bahduri (1973) showed that property owner's double role both as a provider of credit and as a landowner creates a situation such that the property owner may not permit adoption of yield-increasing innovations. On the other hand, tenants' attitudes towards adoption may depend not on the form of the existing lease but on the profitability and risky nature of the new technology.

Bardhan (1979), reported a number of results including the following

- The percentage of area under tenancy will increase if a land-augmenting technological change is introduced.
- Large degree of imperfection in the market for inputs, which are complimentary with HYV cultivation technology leads to a lower percentage of area under cultivation and
- A higher labor intensity of the crop induces a higher incidence of tenancy. However, Place and Hazell (1993) provided empirical evidence that with few exceptions, land rights are not a significant factor in determining investments in land improvements, use of inputs, access to credit or productivity of land

Marketing and Price of Produce

From the early beginning and until the late 1930s the cocoa trade was in the hands of local merchants. Companies such as the United Africa Company, Paterson & Zochonis, Cadbury & Fry, G. B. Ollivant and United Trading Company bought cocoa for export overseas. At its inception in 1947, the Cocoa Marketing Board (CMB) licensed thirty-two buying agents, including the merchant companies. The buying agents dealt with the internal marketing only, with the CMB undertaking the export. The CMB advised the government as to what price to pay to farmers every year, taking into account the world price as well as local factors. However, in 1977, the Government abolished the multiple buying systems again and the Produce Buying Division of the Cocoa Board became the sole agent, buying cocoa and handing it over to the Cocoa Marketing Company for export

In 1992, the Government re-introduced the multiple buying systems with the Produce Buying Company, operating as one of 20 Licensed Buying Companies (LBCs). The LBCs purchase their cocoa through buying centers established in the cocoa producing areas. On the average, about 4 600 buying centers were in operation between 1993 and 1997.

All the local buying companies purchase cocoa from farmers at a minimum price set by a Producer Price Review Committee (PPRC), which comprises COCOBOD officials, a farmers' representative, government representatives and representatives of the LBCs. After purchasing the cocoa, the LBCs invite the Quality Control Division of the Ghana Cocoa Board to grade and seal the cocoa at a fee determined by the PPRC. The LBCs, using private cocoa haulers, evacuate the graded and sealed cocoa to take-over points such as Tema port, Takoradi port and an inland port at Kaase, Kumasi. Officials of the Cocoa Marketing Company take over the cocoa for shipment overseas (Ghana Cocoa Board Report, 2000).

The Committee Report (1995) mentioned that farmers showed interest in the Multiple Buying System and preferred the use of the *Akuafo* Cheque System. However, most farmers expressed dissatisfaction with the irregular and inadequate payment of bonuses. According to the Report, farmers complained about the producer price at the time of the survey (March to April 1994) as being woefully inadequate to ensure adoption of innovations. The Committee further recommended that the producer price policy should take into account the following factors: inflation rate in the country, world market price of cocoa, production cost, incomes from competing crops, adequate profit to the farmer as an incentive for further investment in cocoa production

The Committee also recommended that announcement of producer price should coincide with the reading of the national budget to enable farmers realize the full benefits of its macro effects. Lastly, purchasing of cocoa should be throughout the year on the grounds that hybrid cocoa bears all year round.

According to CIMMYT Economics Program (1993), the adoption of a technology can be hindered or enhanced depending on whether it is in accord with the system of marketing and the organization of input markets. Not only do markets affect acceptability of a new crop variety, they may also influence farmers' interest in any technology that promises higher yields. If markets are inefficient, there may be little incentive to invest in improved technology. In addition, characteristics such as seasonal variation in market prices may affect the acceptability of technologies that change the timing of harvest (e.g., a technique that allows earlier planting).

Constraints to Adoption of Technologies

Feder, Just and Zilberman (1984) observed that constraints to adoption of innovations involved factors such as lack of credit, limited access to information, and aversion to risk. Other factors are inadequate farm size, inadequate incentives associated with farm tenure arrangements and insufficient human capital. The rest are absence of equipment to relieve labor shortages (thus preventing timeliness of operations), chaotic supply of complementary inputs (such as seed, chemicals and water) and inadequate infrastructure.

Among the factors responsible for the decline in cocoa production technology adoption, according to Ghana Cocoa Board Special Report (1994) were old age of farmers; illiteracy status of many farmers, which delays the degree of technology adoption with regard to diseases and pests control unfavorable land tenure system and the inadequacy of good planting material for rehabilitation. Others were lack of well-defined rehabilitation policy, inadequate husbandry practices, lack of credit facilities for farmers and absence of remunerative domestic producer price

MASDAR Consultancy Report, (1997) identified the following constraints resulting in low adoption of technologies and low yields

- Unavailability and high cost of cocoa farm inputs.
- Scarcity and price of labor
- Lack of credit facilities and high interest rates.
- Land acquisition and tenure system.
- Poor farm management practices
- Ineffective and inefficient extension services
- Marketing problems.
- Poor feeder roads which become impassable, especially during the rainy season and
- Activities of timber firms and bush fires cause destruction of cocoa farms.

Asante-Mensah (1988) noted that cocoa farmers in Ghana faced similar constraints to the adoption of recommended technologies. Inadequacy and untimely supply of recommended farm inputs posed a problem towards improvement in levels of adoption of the various practices studied. Notoriously inadequate were the supplies of the recommended hybrid and Amazon cocoa planting material, fuel for the spraying machines and pruners for the control of mistletoe. Insecticides were also sometimes inequitably distributed.

In addition, Anon (1995) identified farmers' constraints to include

1) Low producer price
2) Income and expenditure pattern of farm households
3) High prices of inputs and availability on a sustainable basis
4) Farmer priorities, preferences and capacity to implement research recommendations
5) Pattern of land holdings, tenurial arrangements (e.g. Abusa system), inheritance and fragmentation of farms
6) Lack of workable credit or loan facilities
7) Poor social circumstances of farmers

It seemed paradoxical that in spite of the significant role farmers play in the economy of the country, the majority of cocoa farmers in the rural areas lack basic social amenities, such as good housing, water, electricity, good roads, good health care and education. Whyte and Boynton (1983) observed that the neglect of farmers' non-agricultural needs often results in their lack of response to adoption of innovation.

Best Predictor Variables of Cocoa Production Technologies Adoption

Rogers (1983) stated that economic factors could not be the sole predictors of adoption. Dankwa (2001) confirmed Rogers' assertion when he reported that among the variables of his study, the best predictor of adoption of cocoa technologies was farmer participation in overall implementation of extension programs

Summary of Major Findings of the Literature Review

Various technologies are available for farmer adoption. Farmers' traditional practices show that the norm is low levels of technology usage. Farmers adopt various operations in cocoa production within the farming system. These include site selection, land preparation and shade establishment. Plantation maintenance involves weeding, pruning and pests and disease control. Post-harvest operations include pod breaking, fermentation, drying of beans, quality control and marketing.

Continued and widespread improvement in production requires effective dissemination of technologies to farmers. Technology dissemination involves the role of various organizational arrangements and communication techniques in persuading farmers to adopt a recommended technology. One cannot rule out the role of agricultural extension system in the dissemination of information on known and feasible cocoa production technologies to farmers in Ghana. Agricultural extension is now broadly acknowledged to refer to a pluralistic array of institutions engaged in knowledge and information related to technological change. It is not restricted to the public sector, but the public sector remains, in many countries, a very significant sector.

Arokoyo (1998) noted that for dissemination of cocoa production technologies, Ghana uses the modified Training and Visit System within a unified extension service, which requires the extension agent who is directly in contact with farmers to deliver all messages. The principal channels of communication under the system included visits, demonstrations, publications and farm broadcasts.

An understanding of the processes leading to the adoption of technologies by farmers is important to the planning and implementation of successful technology dissemination. Among farmers, the ability to make decisions regarding resource use and technology varies according to age, gender and other categories. Actual decisions can depend on complex socioeconomic factors such as credit, labor and farm size, etc and the ability to harness them can play a crucial role in adoption decisions.

The number of farmers who adopt a new technology in a specified period is measured by the rate of adoption. Rogers (1983) noted that the characteristics of the innovation, type of innovation-decision, nature of communication channels used, nature of the social system and the change agents' promotional efforts affect the rate of innovation. Farmers tend to selectively adopt components of a package in a stepwise fashion based on various factors. It is conceivable therefore, that one would find that between non-adoption and full adoption, there are categories of adoption in a continuum.

Constraints to adoption reviewed included lack of credit, limited access to information, old age and risk aversion. Economic considerations, such as profitability, cannot be the sole predictors of adoption. The best predictor of adoption of cocoa technology was farmer participation in overall implementation of extension programs.

Conceptual Framework of the Dissemination and Adoption of Cocoa Production Technologies in Ghana

This section identifies the relevant variables of the study and discusses the theories behind their interconnectedness within the context of the study

Cocoa Production Technologies

Cocoa production technologies consist of methods and skills. Others are physical objects, such as tools, equipment and genetic materials. Whatever form they may take, cocoa production technologies are the means by which farmers produce cocoa. Cocoa production technologies derive not only from the laboratories and research stations. Farmers also continuously develop technologies on farms. For instance, farmers have always been-and still are-the principal developers of agro-diversity. Farmers select crops (usually a diversity of species) and varieties (genetic variation within species) to plant, store and select seeds for replanting. Hence, farmers are involved in technology development (selection and testing of varieties and seeds) and maintenance of genetic diversity. Technologies in the study were, therefore, among the products of Cocoa Research Institute, other research organizations that deal with cocoa and cocoa farmers as show in Figure 2

The focus of cocoa production technologies in the present study was on specific technologies employed by farmers including pre-planting, nursery and planting operations. Others were husbandry practices, harvest and post-harvest operations. The rest were cocoa varieties, machinery and equipment used by farmers. All these have a bearing on production and yield. They are therefore important technologies that merit their study.

Farming System

Farmers adopt technologies in a specific operational farming system which according to Reijntjes, Haverkort and Waters-Bayer (1992), is a unique and reasonably stable arrangement of farming enterprises managed according to well-defined practices in response to the physical, biological and socioeconomic environments and in accordance with the farmers' goals, preferences and resources. CIMMYT Economics Program (1993) noted that many times farmers reject a technology that appears as a reasonable innovation not because of any intrinsic quality of the technology itself, but because it conflicts with other elements of the farming system. The adoption study examined the extent to which the technologies were consistent with and influenced by some of the parameters associated with an analysis of the farming system. These included farm size, labor, credit, machinery and equipment. The rest were land tenure and output market.

Technology Dissemination

Technology dissemination involves the role of various organizational arrangements and communication techniques in persuading farmers to adopt a recommended technology. Since many innovations exist for farmers, how to get them to change their low productivity practices to improved ones was the concern of the study. According to Allen (1970), the objective of the dissemination of scientific and technological innovation within research and development should be to foster a two-way flow of information and knowledge in the technology generation, transfer and adoption system as shown if Figure 2. Havelock (1969) mentioned that extension has a role to identify, translate and transfer information and technologies to farmers and to relate to researchers the farmers' constraints for potential research outputs

The study reviewed the key role of extension not only in terms of education and provision of information but also as a catalyst in establishing and strengthening the linkages, partnerships and collaborations between farmers and assorted institutions that reinforce and under gird technology dissemination and adoption. The main aspects covered included extension actors, communication methods, messages and approaches employed in the formulation of extension strategies to disseminate technologies as shown in Figure 2. The study considered various actors, namely, members of staff of MOFA, COCOBOD and CRIG, marketing firms, farmers' organizations and private individuals.

Communication methods studies included group meetings, field visits, demonstrations and mass media among several others. Messages relevant to cocoa production were studied. For instance, the study dealt with messages on establishment, maintenance, post-harvest, bean quality and marketing information etc. The extension approaches explored took cognizance of functional methods adopted by extension to achieve its aims, such as production technology approach, training and visit approach, problem solving approach, commodity-specialized approach and general approach to extension. The focus of technology dissemination was at the level of the individual extension worker in the farming community.

Adoption of Technologies

The major actor in the cocoa production technology adoption drama is, of course, the individual farmer. Each farmer is ultimately a unique individual with a host of decision-making environments that can lead to either adoption, a decision to make full use of an innovation as the best course of action available, or to rejection or non-adoption, a decision not to adopt an innovation. Such decisions can be reversed at a later point, for example, discontinuance is a decision to reject an innovation after it had previously been adopted as shown in Figure 2. It is also possible for an individual to adopt the innovation after a previous decision to reject it (Rogers 1983).

Farmers select livelihood strategies to pursue objectives with the resources available to them. Both the objectives and the available resources vary between farmers and change over time. Thus farmers in the same environment may have different objectives and livelihood strategies, so respond differently to a given technology. Different behavior regarding adoption may be as much a function of different opportunities and constraints as of inherent characteristics or perceptions of farmers (Cramb, 2005).

Among cocoa farmers, the ability to make decisions regarding resource use and technology varies according to age, sex, education, household size and experience that may predispose a farmer to take an interest in a new technology. Actual decisions to adopt can depend also on complex farm related factors like farm size, labor, credit, machinery/equipment, land tenure, yield, marketing and price of produce as mentioned earlier, that may make it easier or more profitable for a farmer to change practices. Hence, the outcomes in terms of adoption decisions will be highly contingent on the interplay between farm resources and farmer characteristics. The study looked at those background characteristics of farmers and farm resources that served as explanatory variables in the study of farmers' adoption behavior.

The dissemination and adoption of cocoa production technologies could therefore, be seen to be mutually inter-related. Researchers, extension workers and farmers all participate to achieve the common goal of sustainable increases in productivity. It is within the context of the overall conceptual framework as shown in the Figure 2 that the study is all about.

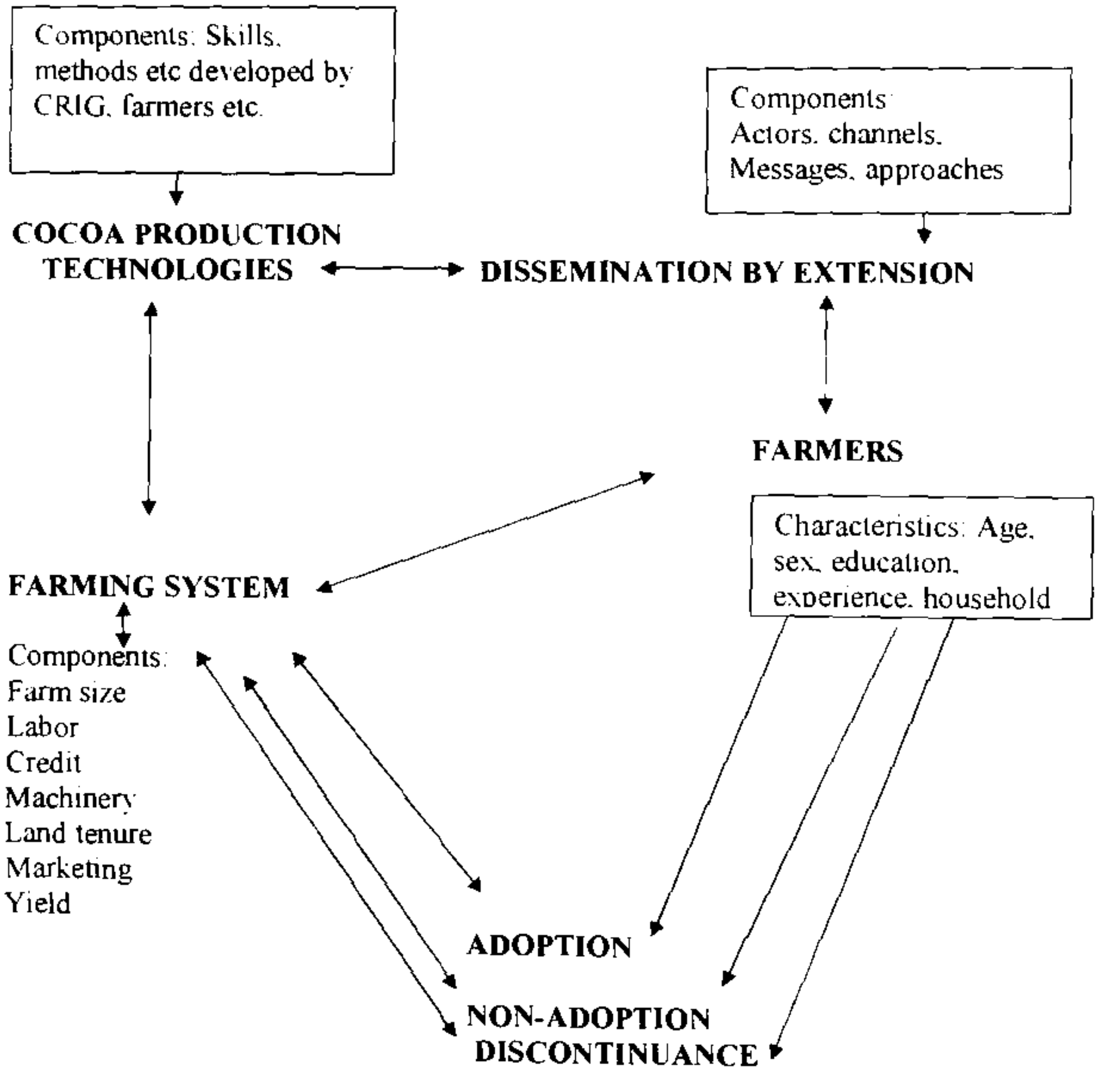

Figure 2. Conceptual Framework of the Dissemination and Adoption of Cocoa Production Technologies Source: Author's Construct (2004)

CHAPTER THREE

METHODOLOGY

Introduction

The section on methodology deals with the research design, population and sampling procedures. Others are research instruments data collection procedure, data processing and analysis. Such a description enables the reader to evaluate the appropriateness of the method and the reliability and the validity of the results. Besides the routine gathering of facts, the study involved analyses that led to the explanation of relationships between the dependent and independent variables of the study.

Research Design

The descriptive-correlational survey design was used to generate data for the study. Isaac and Michael (1984) noted that survey designs collect detailed information that describes existing phenomenon, identify problems, justify current conditions and practices and make comparisons and evaluation. In addition, Warwick and Lininger (1975) stated that descriptive survey design lays the groundwork for the pursuit of other objectives including the explanation and hypotheses testing, prediction and development of indicators.

Furthermore, the choice of the design was based on observations made by Best and Khan (1995), who stated that the descriptive design involves hypothesis formulation and testing. It uses the logical methods of inductive-deductive reasoning to arrive at generalizations. It often employs methods of randomization so that error may be estimated when population characteristics are inferred from observations of samples. The variables and procedures are described as accurately and completely as possible so that other researchers can replicate the study.

However, descriptive methods are non experimental, for they deal with relationships among non-manipulated variables. Since the events or conditions have already occurred or exist, the researcher merely selects the relevant variables for an analysis of their relationships. The survey design explored the reasons for observed practices and pattern of cocoa production. Secondary data sources such as annual reports, journals, books and other relevant literature provided additional information.

The Study Population

Cocoa farmers countrywide constituted the target population for the study. The population consisted of individual cocoa farmers with mature farms.

Sampling

The sample for the study was distributed to obtain maximum geographic spread. The distribution of the sample was therefore based on cocoa farmers within the cocoa-growing belt of Ghana, comprising Eastern, Central, Ashanti, Brong Ahafo, Volta and Western Regions. The study relied on the random sampling technique. According to Best and Khan (1995), the ideal method of sampling is random selection, letting chance or the laws of probability determine which members of the population are to be selected. When random sampling is employed, whether the sample is large or small, the errors of sampling may be estimated, giving researchers an idea of the confidence that they may place in their findings

Respondents were selected on a multistage random sampling basis. Best (1991) recommended multistage sampling method where a population is infinite or a population list is non-existent or unreliable. One of Best's conditions that necessitated the choice of multistage sampling in the present study was the infinite population of farmers in the country. As shown in Table 3, one district was selected at random for each cocoa growing region. The random sampling was by the lottery method. With this method, the names of all the candidate cocoa districts were written on pieces of paper and folded individually. All the folded papers were put in a hat and placed on a table. Six people were asked to pick the folded papers. The names of the first six districts picked were selected for the study. Five villages (as shown in Table 3) were also randomly selected from a list of villages in each of the selected districts, using the same lottery method.

Table 3: Selected Regions, Districts and Villages

Region	District	Towns
Eastern	Kwahu West	Akwasiho, Abampasu, Gyamasi, Abepotia, Odumasi
Central	Asikuma-Odoben-Brakwa	Ayipey, Benin, Amoanda, Adosia, Nyakrom
Ashanti	Asante Akim South	Adumasa, Juansa, Domeabra, Nobewam, Odumase
Brong Ahafo	Brekum	Chiraa, Yawhima, Yeboakrom, Asikasu, Abesim
Volta	Hohoe North	Likpe Kukurantumi, Lolobi Kumasi, Likpe Abrani, Baika, Santrokofi
Western	Amamfi East	Wassa Akropong, Japa, Gromisa, Amaninkrom, Abeneso

Source: Field data, 2004

Size of sample

In each village, six farmers were selected by the lottery method. Obviously, each of the villages did not have an equal number of cocoa farmers (potential respondents). Limiting the sample size to six did not assume that all the villages had the same number of cocoa farmers. The sample size was chosen with the assumption that a probable homogeneity existed among farmers within the villages, in terms of method of production, attitudes, and perceptions and for convenience.

The sampling was straightforward because registers of cocoa farmers existed in every village. Supervisors of the Cocoa Diseases and Pest Control Program kept the registers. This gave 30 farmers in each district. The sampling was therefore based on farmers' participation in the Cocoa Diseases and Pests Control Program. According to CIMMYT Economics Program (1999), respondents might be as few as 50-60 but the complexity of the adoption process is such that 80-120 respondents is a more usual sampling size for farmers. The sample size was 180, considered more than adequate for the purpose of the study

Research Instrument

The research instrumentation involved the use of detailed structured interview with questions shown in (Appendix I). The instrument was based upon a carefully designed structure, thus ensuring that valid information was elicited. The instrument went through several drafts as colleagues and experts reviewed it. The critical judgment of the principal supervisor of this project and experts in the field of agricultural extension was taken into consideration in selecting the essential questions. In developing the instrument, some questions were pre-coded so that the participants' responses corresponded to one of a limited number of choices. The farmers answered in their own words, at some length, open form questions. This likely provided greater depth of response.

The review of literature identified the recommended technologies for the study of adoption. Information on technologies involved in the establishment and maintenance of cocoa farms formed part of the instrument. This was followed by information on communication factors i.e. channels, messages, approaches etc associated with technology dissemination. Questions to determine the rate and level of adoption of technologies were also included in the instrument. Personal and background characteristics of farmers as regards sex, age, educational level, experience and house hold size formed part of the instrument to determine their relationships with level of adoption of technologies. Farm related factors, notably, farm size, labor, credit, land tenure arrangement, marketing and producer price, featured in the instrument to show their relationship with adoption of technologies. In addition, farmers were asked to state the constraints that limit the adoption of technologies in the instrument.

The Likert-type scaling technique scored farmers' preferences for extension approaches and channels of communication. In constructing the Likert-type scale, a number of statements about the farmers' preferences were made. These were given the following scores: 5 = most preferred, 4 = next preferred, 3 = somewhat preferred, 2 = least preferred and 1 = not preferred.

The Likert-type scaling technique was also used to assign a scale value to each of the five statements concerning farmers' level of adoption as follows: 0-5 very low, 6-10 low, 11-15 moderate, 16-20 high, above 20 very high. The test scores obtained on the items then measured the respondents' favorableness toward the given point of view. The Likert-type scale was adopted because it suited the purpose of the study.

The instrument was pre-tested at Dunkwa-on-Offin in the Central Region. Eighteen farmers were selected according to the lottery method of random sampling for the pilot test. The selection of Dunkwa-on-Offin was purposive and for convenience. Two interviewers participated in field-testing of the instrument. The interviewers underwent training to ensure that they presented and interpreted the questions correctly and had a thorough understanding of the questions. This was done to ensure that the statements conveyed the appropriate meanings and measured the variables accurately.

The reliability coefficient was 0.72 Cronbach's alpha. This measured the internal consistency of items in the scale of farmers' preferences for extension approaches and communication channels as well as levels of adoption of technologies. According to Nunnelly (1978), the alpha of the scale should be greater than 0.70 for items used together as a scale.

Data Collection Procedure

The trained enumerators administered the instrument through interview schedule with the farmers. The farmers gave the needed information orally and face-to-face. The instrument was administered to farmers in the comfort of farmers' homes. The interview was considered superior to other data-gathering devices. One reason was that people are usually more willing to talk than to write. After the interviewer gains rapport or establishes a friendly, secure relationship with the subject, certain types of confidential information may be obtained that an individual might be reluctant to put in writing. Another advantage is that the interviewer can explain more explicitly the investigator' purpose and just what information is wanted. At the same time, he or she may evaluate the sincerity and insight of the subject (Best and Khan, 1995). Moreover, not all the farmers could read and write.

The interviewers who administered the instruments had an opportunity to establish rapport, explained the purpose of the study and explained the meaning of items that might not be clear. In conducting the interview, ethnic origin seemed to be important. Interviewers of the same ethnic background as farmers seemed to be successful in establishing rapport. In the Hohoe district, where there was an ethnic difference between the enumerators and the farmers, local trained enumerators conducted the interviews. The interviewers operated in a team of two, with one responsible for asking questions, and the other for recording. The data was collected from November 2004 to January 2005.

Data Processing and Analysis

Coding began after the completion of the survey. The purpose of the coding was to classify answers into meaningful categories to bring out their essential pattern for analysis. The Statistical Product and Service Solutions (SPSS) Version 10.0 procedure was used to measure variables of the study. Descriptive statistics involving frequencies, means and percentage distributions were computed to describe the following objectives

- Technologies involved in establishment and maintenance of cocoa farms;
- Communication factors associated with the dissemination of cocoa technologies.
- Background characteristics of farmers including age, sex, educational level, experience and household size;
- Farm-related factors including, farm size, labor, credit, equipment, land tenure, yield, marketing and producer price; and
- Constraints that limit the adoption of technologies.

Correlation technique was used to determine the nature and strength of the relationships between the level of adoption, as the dependent variable, and the independent variables, consisting of some background characteristics and the farm- related factors. The degree of relationships were measured and represented by Pearson-Product-Moment Coefficient of Correlation (r). This was used because it is appropriate.

Stepwise regression identified the best predictors of adoption. From the results obtained in the correlation matrixes, variables that showed significant correlation with the dependent variable under consideration were selected for the regression analysis. With this procedure, explanatory independent variables enter the regression equation in single steps from best to worst. The explanatory variable that explained the greatest variance entered first. The variable that explained the greatest amount of variance (in the dependent variable) in conjunction with the first enters second and so on. Alpha level of 0.05 determined the statistical significant differences.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

Introduction

The Chapter summarizes the data collected and the statistical treatment of them. The discussions that follow examine, interpret and qualify the results, as well as draw inferences from them. The chapter also deals with discussions of the results, showing their importance and implications in terms of the study. Included in the chapter are the technologies involved in the establishment of cocoa farms, communication factors associated with dissemination of technologies and adoption of cocoa production technologies. Other aspects covered in the chapter include background characteristics of farmers, farm-related factors and their relationships with level of adoption of technologies. The rest are constraints to the adoption of technologies and variables that best predict the adoption of technologies.

Technologies Involved in Establishment of Cocoa Farms in Ghana

The section deals with the period during which farmers established their farms. It also includes the practices or activities undertaken by farmers in establishing cocoa farms

Period of Establishment of Farms

The year of establishment of farms appears in Table 4. About one-third of the farms were established before 1980, while nearly 44 % of the farms were established in the 1980s. Farms established after 1990 accounted for 24.4 percent. Majority of farms were, therefore, in their productive stages. However, most of the farms require regeneration to ensure higher yields. Regeneration could be in the form of total replanting, partial replanting, or regeneration from stumps or grafting. Farmers can take advantage of new technologies in the regeneration exercise to achieve optimum yields.

Table 4: Period of Establishment of Cocoa Farms

Period	Frequency	Percent	Cum %
1950-1959	18	10.0	10.0
1960-1969	14	7.8	17.8
1970-1979	25	13.9	31.7
1980-1989	79	43.9	75.6
After 1990	44	24.4	100.0
Total	180	100.0	

Source: Field data, 2004 N= 180

Choosing the Site

As shown in Table 5, in choosing particular sites for cocoa plantation, majority of farmers (60 %) relied on the type of soil. The rest decided on land availability, forestlands and on ideal weather conditions. An accurate assessment of the physical characteristics of the soil influences how farmers accept new technologies. Farmers decided on the weather conditions in choosing the site for farming because the development of the crop and the adoption of technologies depend to an extent, on the weather conditions. Farming in new forest areas results in forest depletion, environmental degradation and adverse climatic changes. According to Madsar environmental degradation and adverse climatic changes. According to MASDAR Consultancy Report (1997), pressure of land for food crops due to population increase takes away some of the land available for cocoa. Therefore, the potential to increase cocoa output lies in the intensification on existing cocoa farms, rehabilitation of abandoned farms and replanting in old areas.

Table 5: Criteria for Site Selection

Selection criteria	Frequency	Percentage	Cum. percentage
Ideal weather	11	6.1	6.1
Good soil	108	60.0	66.1
Forest land	30	16.7	82.8
Land availability	31	17.2	100.0
Total	180	100.0	

Source: Field data, 2004 **N= 180**

Land Preparation

Majority of farmers cleared completely the undergrowth, burnt weeds and thrash and felled large forest trees during the dry season. Farmers did not remove large tree stumps probably due to the tedious nature of work involved in their removal. However, it is necessary to remove as many tree stumps and roots as possible, otherwise they will be potential sites for root rot and could shelter rodents and other predators. Furthermore, the stumps will always be in the way of cultural operations. Stumps of large trees should be removed by chain sawing and by progressively loosening the roots (Mossu, 1992)

Spacing

Table 6 shows the pattern of spacing adopted by farmers during planting. While 50.6 % of farmers interviewed planted at random, nearly one-third of farmers used a spacing of 3 m by 3 m. The remaining 16.9% adopted a closer spacing of 2.4 X 2.4 m. Asante-Mensah (1988) also noted that most farmers planted at random.

Lack of knowledge could be a reason for non-adoption of recommended planting distance. Farmers' preference for the traditional random planting was because it was quicker and easier to practice. Random planting also enabled the trees to form a canopy earlier to control weeds. The 3m by 3m spacing is the current recommendation for planting hybrid cocoa, making it easier and faster for farm maintenance operations.

Table 6: Spacing Adopted by Farmers

Spacing	Frequency	Percent	Cumulative %
3m by 3m	57	31.7	31.7
2.4m by 2.4m	32	17.8	49.4
Random	91	50.6	100.0
Total	180	100.0	

Source: Field Data, 2004 **N= 18**

Time of Planting

The months during which farmers planted their farms appear in Table 7. In most farms, planting took place between May-July. Only 5.5 percent of farmers planted in August-October. The implication is that most farmers planted during the main rainy season, and in most cases, planting took place as soon as the rainy seasons were established.

Table 7: Month of Planting Cocoa

Month	Frequency	Percentage	Cum. %
May	66	36.7	36.7
June	85	47.2	83.9
July	19	10.6	94.5
August	5	2.7	97.2
September	3	1.7	98.9
October	2	1.1	100.0
Total	180	100.0	

Source: Field Data, 2004 **N= 180**

Sources of Planting Materials

Farmers' responses on sources of planting materials appear in Table 8. Most of the farmers used planting materials from the Seed Production Unit (SPU) of Ghana Cocoa Board. Nearly one-third of farmers used planting materials from farmers' farms. In addition, about 12 per cent of farmers established nurseries of their own while the rest obtained planting materials from private nurseries. The Government should increase assistance for the Seed Production Unit to enable the Unit continue to help farmers with seed pods for the establishment of farms.

It may be cost-effective to establish one's own nursery. It is also more convenient to transplant seedling raised in one's own farm. Farmers should be sure of the source of planting materials of private nurseries before buying them to ensure they get value for their money. Farmers, who obtain pods from neighbors' farms perhaps, relied on the phenotypic expression of the planting material without taking the genetic constitution into consideration.

Table 8: Source of Planting Materials

Source	Frequency	Percentage	Cumulative %
Farmers' Farm	58	32.2	32.2
Own Nursery	21	11.6	43.9
Private nursery	6	3.3	47.2
SPU	95	52.8	100.0
Total	180	100.0	

Source: Field Data, 2004 **N= 180**

The above results show that the cultivation of recommended hybrid cocoa needs intensification for higher yields. The results further point to the need to educate farmers on the importance of planting only hybrids Hybrids ensure early maturity, higher yield and disease tolerance

Method of Planting

Table 9 shows the methods of planting adopted by farmers Nearly 43 % of farmers used seedlings in transplanting. About 36% planted seeds at stake, while about 21 % planted with both seeds and seedlings. Planting seedlings ensures better establishment in the field. On the other hand, planting at stake is less expensive.

Table 9: Distribution of Farmers by Method of Planting

Method	Frequency	%	Cum %
Planted seeds at stake	65	36.1	36.1
Transplanted seedlings	78	43.3	79.4
Both	37	20.6	100.0
Total	180	100.0	

Source: Field Data, 2004 **N=180**

Harvest and Post-harvesting Operations

The section deals with the frequency of harvests, pod breaking, fermentation and drying of beans

Frequency of Harvests

The patterns of harvesting of cocoa appear in Table 10. Majority of farmers harvested pods at a weekly or fortnightly interval, while the rest harvested any time pods were ripe, once a month or when majority of pods were ripe.

The implication of the results is that about 42 per cent of farmers who harvested once a month or any time the majority of the pods were ripe delayed in harvesting ripe pods. Any delay in harvesting leads to poor quality produce. Labor for harvesting is an important factor influencing frequency of harvesting. Farmers could employ the services of the "nnoboa" system to ensure more frequent harvests. Farmers need education on the importance of early and regular harvesting.

Table 10: Frequency of Harvests of Crops

Frequency	Number of farmers	Percent	Cum. %
Any time pods are ripe	33	18.3	18.3
When majority are ripe	37	20.6	38.9
Every week	3	1.7	40.6
Fortnightly	68	37.8	78.3
Monthly	39	21.7	100.0
Total	180	100.0	

Source: Field Data, 2004 **N=180**

Pod Breaking

Majority (93.[illegible] %) of farmers opened pods with machetes to remove beans while only few farmers used wooden clubs. With machetes, the possibility of cutting some beans during pod breaking is common. This reduces bean quality. Farmers should therefore use wooden clubs in pod breaking [illegible]. While majority of farmers (73.3 %) broke pods one to three days after harvesting, the rest of farmers left pods at least four days before breaking. This could result in over-ripening of pods. Over ripening of pods leads to attack by pod diseases, making them unfit for processing. More farmer education and labor availability could solve the problem of delay in pod breaking after harvesting.

Fermentation

As shown in Table 11, about 26 % of farmers fermented beans for a period ranging between two and five days. Majority (68.9 %) of farmers interviewed fermented beans for six days, while 5.0 % of farmers fermented beans for more than six days. All farmers interviewed carried out fermentation of beans by placing them in heaps covered with banana or plantain leaves.

There are other methods of fermentation available to farmers. These are the box, tray and basket methods. Farmers opted for the particular one being practiced because it is readily available and adopted at no or less cost.

Poor fermentation results in slaty beans. Under fermentation leads to purple beans, while excessively long period of fermentation results in very dark brown beans, with black marks. The concern that rose about the

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Poor fermentation results in slaty beans. Under fermentation leads to purple beans, while excessively long period of fermentation results in very dark brown beans, with black marks. The concern that rose about the appreciable percentage of purple beans produced by farmers during the last crop season, calls for proper fermentation of beans to ensure good quality produce. Extension needs to intensify education on fermentation of beans to ensure good quality produce.

Table 11: Number of Days of Fermentation of Beans

Days	Frequency	Percentage	Cum %
Less than six	47	26.1	26.1
Six	124	68.9	95.0
More than six	9	5.0	100.0
Total	180.0	100.0	

Source: Field Data, 2004 **N=180**

Drying of Beans

Sun drying was the only method used in drying cocoa by farmers interviewed. Most farmers dried beans on raffia mats mounted on supports. According to Mossu (1992), sun drying is the simplest and also the most frequently used method in most of the producing countries. It does, of course, depend on the climatic conditions and, in general, the beans have to be exposed for one to two weeks.

Communication Factors Affecting Dissemination of Technologies

The section presents farmers' perceptions and opinions on dissemination of cocoa production technologies. The section begins with farmers' awareness of the unification of the extension services of MOFA and Cocoa Services Division. This is followed by farmers' familiarity with the extension workers in charge of the villages. Frequency of extension visits to farmers, various organizations that disseminate cocoa production technologies to farmers and farmers' preferences of agencies to take charge of cocoa extension are also presented in the section. In addition, the section deals with communication channels, messages and approaches to extension.

Farmers' Awareness of MOFA's Responsibility of Cocoa Extension

As shown in Table 12, most farmers (62.2 %) were aware that the MOFA took over the responsibility of cocoa extension from the erstwhile Cocoa Services Division of COCOBOD under the unified extension services. These farmers could, therefore, consult the MOFA extension workers when in need of advice. On the other hand, nearly 38 % of farmers were not aware that MOFA was in charge of cocoa extension.

The implication is that more than one-third of farmers who did not know about the merger might not approach the MOFA extension workers in charge of their villages with queries regarding cocoa production practices. This could be a constraint to adoption of technologies by the farmers concerned. An important aspect of extension-farmer interaction is the extent of farmers' knowledge of the extension worker assigned to the villages. While information will diffuse among farmers through communication with one another, the ability to get timely information to address specific production problems diminishes if farmers do not know the extension workers to contact.

Table 12: Farmers' Awareness of Unified Extension Services

Awareness	Frequency	Percentage
Not aware	68	37.8
Aware	112	62.2
Total	180	100.0

Source: Field Data, 2004 **N=180**

Frequency of Extension Agents Visits to Farmers

This study used the frequency of contacts between extension workers and farmers in the year as a measure of quality of extension delivery. There is the need to review the current extension delivery to ensure more contacts between cocoa farmers and extension agents. As shown in Table 13, farmers who never had any visit by an agent from MOFA during the year under review constituted 40.6 %. Forty five (45 %) of farmers had occasional or once in a year visits by extension agents from MOFA. Nearly 14 % mentioned fortnightly to monthly visits by extension agents. Similarly, Asante (2001) reported that 45 percent of farmers had no contact with extension staff throughout 2000/2001 cropping season.

Table 13: Frequency of Extension Agents' Visits to Villages per Year

Visits	Frequency	Percentage	Cumulative %
Never	73	40.6	40.6
Fortnightly	2	1.1	41.7
Monthly	13	7.2	48.9
Quarterly	11	6.1	55.0
Occasionally	62	34.4	89.4
Bi-annually	1	0.6	90.0
Once a year	18	10.0	100.0
Total	180	100.0	

Source: Field Data, 2004 **N=180**

On the contrary, 50.6% of farmers received 1-4 times visits in a month from the extension agents under the CSD extension. Only 24 % received no visits at all (Asante-Mensah 1988). Moreover, Countywide Report on Cocoa (1995) showed that 60.6 % of farmers received extension visits 1 to 2 times per month under CSD. About 23.0 % of farmers had visits three to six times per year. Nearly 16.4 % said visits were once a year. Dankwa (2001) also reported that the least visits made by agents of CSD were monthly. Perhaps, the current poor situation of extension visits per year to villages arose from the unification of extension services. Currently, extension agents deal with all categories of farmers. Cocoa farmers receive less attention than before. However, the efficiency of every extension system depends on the extent that extension agents interact with farmers to disseminate innovations. Such visits also help agents offer solutions to farmers' problems. Extension agents pass on to researchers problems they cannot solve after contacts with farmers.

Farmers' Experience with Extension Workers

Responses pertaining to farmers' experience with extension workers appear in Table 14. While 35 % of farmers had over ten years working experience with extension workers, majority (65 %) of farmers had not more than ten years experience. About 24 percent of farmers had not yet had any experience with extension workers. The discrepancy in the figures of 40.6 % in Table 13 and 24.4 % in Table 14 on the visits of extension agents and farmers' experience with extension workers could be explained by the fact that the visits of extension workers took into consideration only the year under review. On the other hand, the farmers' experience with extension workers took account of the entire period of farmers' career.

Dankwa (2001) noted that majority of cocoa farmers had worked with agents up to ten years. Very few (1.3 %), were yet to work with an agent. Farmers with more years of experience with extension workers are likely to benefit more from extension. Experience with extension is a key to successful farming career. The more experience a farmer has with extension workers, the more such experience could lead to adoption of technologies, and vice-versa.

Table 14: Farmers' Experience with Extension Workers

Period	Frequency	Percent	Cum %
Not yet	44	24.4	24.4
Less than 3 years	37	20.6	45.0
3-10 years	36	20.0	65.0
Over 10 years	63	35.0	100.0
Total	180	100.0	

Source: Field Data, 2004 **N=180**

Agencies Dealing with Cocoa Technology Dissemination Apart from MOFA

As shown in Table 15, the most often-mentioned organization that rendered cocoa extension to farmers apart from MOFA was the CSSVD Unit Control Unit of the Ghana Cocoa Board. The staff of CSSVD Control Unit provided 79.4 % of farmers with extension services on all aspects of cocoa production.

About 11 % of farmers received extension services from Cocoa Coffee Sheanut Farmers' Association (CCSFA). That was not good enough. The Extension service could act as catalyst agents to stimulate farmer's association building. Such associations may assist farmers to acquire knowledge, hire inputs and organize marketing of produce. Such associations may also act as an interface between COCOBOD and farmers. CRIG participated in the Cocoa Diseases and Pests Control and the Hi-Tech programs and offered extension services to farmers 11.2 per cent of farmers. Marketing firms also provided extension to 5.6 per cent of farmers. Notable among the firms were

Reiss and Company Limited and Weinco The companies provided extension along side the promotion of their products

Table 15: Agencies Dealing with Cocoa Technology Dissemination Apart from MOFA

	Yes		No	
Organization	Frequency	%	Frequency	%
CSSVDCU	143	79.4	37	20.6
CCSFA	19	10.6	161	89.4
CRIG	20	11.1	160	88.9
Marketing firms	10	5.6	170	94.4

Source: Field Data, 2004 **N=180**

According to Adegbola (1979), cooperatives, farmers associations and members of staff of the MOFA provided extension education to cocoa farmers in Nigeria. Other agencies that dealt with cocoa extension included staff of the Cocoa Development Units and researchers of the Cocoa Research Institute of Nigeria. Alternative extension agencies such as traders, seed and agrochemicals companies, non-government organizations were found to be unimportant in the communities surveyed.

Farmers' Preference for Organization to Take Charge of Cocoa Extension

Table 16 showed that 88.3 % of farmers favored the erstwhile (CSD) to provide cocoa extension, while six percent of farmers wanted MOFA to take responsibility of cocoa extension. In addition, five percent of farmers wanted Cocoa Research Institute of Ghana to add cocoa extension to research activities, while only one farmer (0.6 %) chose privatization of cocoa extension services.

Table 16: Farmers' Preferences for Organizations to Take Charge of Cocoa Extension

Organization	Frequency	Percent	Cumulative %
CSD	159	88.3	88.3
MOFA	11	6.1	94.4
CRIG	9	5.0	99.4
Private Firms	1	0.6	100.0
TOTAL	180	100.0	

Source: Field Data, 2004 **N=180**

Farmers opted for (CSD) because the staff of CSD gave advice mainly on cocoa. Farmers also had regular and frequent contacts with the extension workers of CSD. Members of staff of the CSSVD Control Unit and Seed Production Unit of COCOBOD continued to take up the responsibility of cocoa extension as they go about their normal operations. Few farmers wanted MOFA because the organization deals with both crops and animals and so have to contend with many farmers. Majority of farmers were not in favor of privatization of extension because of the cost involved, which might be beyond the ability of farmers to pay

Farmers' Preferences for Methods of Technology Dissemination

As shown in Table 17, about 29 % of farmers preferred Group Meetings. By utilizing group techniques, an extension worker can reach more people than is possible by following individual methods alone. This is an important factor when time and staff are limited. Group methods are especially effective in persuading extension's clientele to try a new idea or practice.

Nearly 22 percent of farmers preferred Visits. The farm and home visit involves meeting individually with the farmer or farm worker at the farm or home. A farm or home visit serves a number of purposes. For instance, it establishes contact with farmers and others within the farm household. It also enables extension workers to learn what practices and problems exist on the farm and in the farm household. Moreover, extension workers provide information and assistance to farmers on relevant innovation during such visits. This technique builds up confidence in the extension system. However, farm or home visit is costly in terms of time spent and the number of clients contacted, which will necessarily be few.

Field trips and Printed materials followed farm and home visit in order of most preferred channels. About 13 % of farmers selected field trips as the most preferred method. On a field trip, a group travels to another location to observe agricultural practices, projects, or demonstrations not available locally. The purpose is to provide first-hand observation of practices that might be of benefit to the farmer. Field trips enable the group to interact with individuals knowledgeable about the practices In addition, field trips present a fresh and different learning environment for both the extension worker and farmers

The high literacy rate among farmers interviewed suggests that the extension services can use symposia and printed materials to an advantage With a high level of farmer literacy, it was surprising to observe the low preference level of these extension methods as communication strategies to reach the listeners (Laird, 1972)

A symposium is a meeting in which two-five resource people give short, prepared papers on a given topic. Interaction with the audience is not expected. The symposium is primarily for information gathering at the professional level. There is no wonder that only 11.1 % of farmers made it the most preferred method. Only 6.7 percent of farmers chose printed materials as the most preferred method. Printed media covers those communication techniques that rely principally on combinations of printed words and pictures Printed materials include newspapers, blackboard news, folders, leaflets, pamphlets, fact sheets and newsletters. To use them effectively, extension workers should consider the educational levels and literacy rates of the audience. Extension programs can take a broad and creative approach to ways in which to use print methods for conveying news to literate cocoa farmers

Radio rated among one of the least most preferred channels of communication in the present study. Only 5.6 % of farmers selected radio as the most preferred channel. According to Asante-Mensah (1988), about 56% of farmers owned radios. Majority of farmers (69 %) considered the information they received on cocoa as little. However, about 39 % mentioned that they received some information on the radio. Radio has limitation in its ability to convey detailed and complex information. Listeners cannot see what presenters describe. On the other hand, radio reaches large numbers of people, especially as Frequency Modulation (FM) stations are common in recent times. Listeners can take their radio wherever they go, even to their farms where electrical power is not available. Extension workers may find that radio works most successfully at the local level, to communicate local problems, solutions and activities. Radio could be more effective as a communication channel if extension workers organize farmers into listening clubs and groups. Farmers can then have in-depth discussions of broadcasts and feedback to program producers, thus making it a two-way channel.

Less than ten percent of farmers considered Television as the most preferred channel of communication. This is not unexpected. Considering the number of Televisions that are available to the intended audiences, it may be useless to use Television programs for rural audiences, if the rural folk do not have the necessary receiving equipment, or they live outside the range of the transmitter. Taking all the channels into consideration, office call was the least preferred. Only about four percent of farmers mentioned office calls as the most preferred method of communication. Office calls and enquiries are personal visits made by extension clientele to the extension office, to seek information and assistance. A visit to the extension office is a statement of confidence in the extension officer and his or her advice.

To the extent that communication methods are used in cocoa extension, Arokoyo (1998) noted that the principal methods of communication employed for extension delivery under the training-and-visit system included visits, demonstrations, publications and farm broadcasts (mainly by radio). However, extension agents' visits and radio were the most important methods of research results information to Nigerian cocoa farmers.

Table 17 Farmers' Preferences for Methods of Technology Dissemination

Method	Frequency	Percent	Cum %
Group	53	29.4	29.4
Visit	40	22.2	51.6
Field Trip	24	13.3	64.9
Symposium	20	11.1	76.0
Print Material	12	6.7	82.7
Radio	10	5.6	88.3
T V	13	7.3	96.6
Office Call	8	4.4	100.0
TOTAL	180	100.0	

Source: Field Data, 2004

Adegbola (1979) also mentioned that extension methods of communication intensified in Nigeria included regular meetings with farmers. In addition, distribution of information pamphlets, showing the calendar of all farm operations throughout the year and giving information on sites for the collection of planting materials, fertilizers, and other inputs in different localities was also carried out. Project staff were also encouraged to make regular visits to farmers on their farms for the purposes of supervising and training them in different skills, which were aimed at improving their knowledge of the methods of farm practices. Gyamfi and Owusu (1979) noted that extension workers in Ghana used film shows. They further mentioned that pictorial quality of films and their ability to combine sight and sound are powerful stimulants to learning and are effective in giving instructions on specific procedures in agricultural improvements.

Channels Used by Farmers to Acquire Information

As shown in Table 18, most farmers used group meetings to acquire information from extension workers. Group meetings were featured in the Training and Visit System of extension adopted for cocoa extension. The finding confirms the fact that most farmers preferred the group method of extension. In addition, about 42 per cent of farmers used personal contact. This is because the channel provides the farmer with a degree of confidentiality. Although the method is time-consuming, yet its importance cannot be stressed enough. This is because it is through working individually with the clientele that the extension worker learns about the people of the area. By this method, he knows how they think, what their needs are, and how they carry out their work. Equally important is the opportunity personal contact provides for the farmer to get to know the extension worker.

However, Behrens and Evans (1989) noted that personal, face-to-face methods could not reach every one in need of information. Few farmers used print materials even though most farmers were literates. Only one farmer used telephone. This is obvious. Many a farmer in the rural area does not have access to telephones. Many agricultural offices in the districts lack telephone facilities.

Table 18: Channels Used by Farmers to Acquire Information on Cocoa Production

	Yes		No	
Channel	Frequency	%	Frequency	%
Group meetings	100	55.6	80	44.4
Personal contact	75	41.7	105	58.3
Demonstration	29	16.1	151	83.9
Office call	20	11.1	160	88.9
Seminar/symposium	17	9.4	163	90.6
Print material	11	6.1	169	93.9
Telephone	1	0.6	179	99.4

Source: Field Data, 2004. **N=180**

In Brazil, Vos and Krauss (2002) noted that success in extension education resulted in the upgrading of cocoa plantations from a production level of 100,000 tons per year in the early 1960s to four-fold production level in the 80s through technology transfer, aimed at modernizing cocoa cultivation. Extension methods employed included annual farmers' days, meetings, and courses. Other methods were field days, excursions, and campaigns. The rest were demonstration plots or farms and various mass communication activities, such as special early morning radio programs and contributions to newspapers, bulletins, folders and posters. The success story in Brazil points to the assertion by Fliegel (1989) that a combination of extension methods is the ideal.

Content of Extension Messages and the Varieties of Content

As shown in Table 19, the study considered the content of extension messages and the varieties of the content among farmers in the study during the year under review as another measure of the quality of extension delivery. Majority of farmers received information on diseases and pest control and supply of chemicals during interaction with extension workers. This is not unexpected. Mossu (1992) estimated that the combined activities of diseases and pests mean that only 54 per cent of the potential total production reaches the world market. About 55.6 % of farmers also enquired about lining and pegging, when they consulted extension workers.

Asante-Mensah (1988) noted that the high percentage of non-adopters of lining and pegging perceived the practice as complex. Majority of farmers in the present study enquired about this practice from extension workers because they presumably, perceived the practice to be complex. Additionally, minority of farmers contacted extension workers for advice on planting materials, nursery establishment and maintenance operations. Farmers should also be made aware of the importance of recommended cultural practices to ensure proper maintenance for higher yields.

Majority of farmers did not seek information on harvesting and fermentation of beans. A vast majority of farmers also did not enquire about bean quality. This might explain the hullabaloo about purple beans during the last crop season. Nevertheless, proper fermentation and good quality beans earn Ghana higher price/premium on the international market. Of significant importance to the cocoa industry is the proper harvest and post-harvest management, which can have a tremendous impact on the yield, quality and safety of the produce. Extension services should focus more attention on harvest and post harvest handling of cocoa to ensure excellent quality of produce.

Table 19: Contents of Extension Messages and Varieties of Content

Information	Yes		No	
	Frequency	%	Frequency	%
Disease/pest	157	87.2	23	12.8
Line pegging	100	55.6	80	44.4
Chemicals	93	51.7	87	48.3
Nursery	82	45.6	98	54.4
Plant materials	80	44.4	100	55.6
Maintenance	77	42.8	103	57.2
Fermentation	52	28.9	128	71.1
Harvesting	46	25.6	134	74.4
Bean quality	26	14.4	154	85.6
Marketing	14	7.8	166	92.2

Source: Field Data, 2004. **N=180**

The result shows clearly that majority of farmers sought production-oriented information from extension workers. Few farmers sought information on marketing. Karunadasa (1996) stated that in the developing countries, extension services focus on production-oriented agricultural extension, while marketing extension receive less attention. In Asia, reference can be made to sustainable cocoa extension services for smallholders, which targets training to management of cocoa pod borer through proper pruning and frequent harvesting and to crop improvement through fertilization. In Brazil, farmers received information on substitution of planting material with hybrids.

improving agronomic practices, management of shade and pests and introducing soil sampling procedures and fertilizing practices as noted by Vos and Krauss (2002).

Farmers Preferences for Extension Approaches

The results of the analysis of the farmers' preferences of extension approaches appear in Table 20. Nearly 66 % of farmers preferred Production Technology Approach.

Table 20: Farmers' Preferences for Extension Approaches

	Percentage Degree of	Preferences					
Approach	5	4	3	2	1	Mean	Std
Production Technology	66.2	14.3	9.7	0.6	9.2	4 2,792	1 2,393
T & V	39.2	18.2	15.6	15.5	11.5	3 5,811	1 4,286
Problem-solving	38.3	34.2	21.5	4.7	1.3	4 0,336	0 9,545
Commodity-specialized	14.0	11.8	32.4	25.0	16.8	2 8,088	1 2,562
General	10.4	38.2	29.2	15.3	6.9	3 2,986	1 0,714

Source: Field Data 2004 **N=180**

Scale: 5= Most Preferred, 4=Next Preferred, 3= somewhat preferred,

2= Least preferred 1= Not Preferred

About 39.2 % preferred the Training and Visit Approach. In addition, 38.3 % of farmers chose Problem-solving as their most preferred approach. The Commodity-specialized Approach followed with 14.0 % of farmers' choices as the most preferred approach. In comparison with all the extension approaches listed, the General Extension Approach was the least preferred among farmers. Only ten percent of respondents chose the General Approach as the most preferred.

Most farmers preferred production technology approach to other approaches because the erstwhile Cocoa Services Division adopted this approach. Cocoa farmers were used to this approach, which assured them of relevant advice on recommended cocoa innovations from CSD extension workers. According to Arokoyo (1996), Ghana modified the visits required by the Training and Visit System to monthly rather than fortnightly to suit local and economic demands, no doubt, with a corresponding reduction in coverage and effectiveness. This could explain why farmers relegated this approach to second position of preference.

Improving the Effectiveness of Cocoa Extension

Respondents gave views on ways to improve the effectiveness of cocoa extension. Majority of farmers wanted the reintroduction of CSD for cocoa extension. Farmers also called for reduction of extension worker-farmer ratio, which according to Arokoyo (1998) stood at 1:1,200 in Ghana. This will ensure regular interaction between extension workers and farmers. In addition, farmers called for the provision of adequate training, accommodation, and means of transport to extension workers to improve the effectiveness of extension.

Adoption of Production Technologies

The section deals with the rate and levels of adoption of cocoa production technologies. The technologies are categorized into pre-planting, nursery, planting, maintenance and chemical applications. The rest are harvest and post-harvest technologies.

Rate of Adoption of Cocoa Production Technologies

The section includes historical data that provide information about trends of the adoption of technologies. As shown in Figures 3 to 23, the years of first adoption of technologies varied from 1933 through 1980. In most cases, only few farmers adopted a particular technology in each year of first adoption. Ryan and Gross (1943) and Lionberger (1960) indicated that a small number of farmers adopted an innovation initially, followed later by the majority of farmers. Farmers who adopted the technologies for the first times were the innovators.

According to Rogers (1983), innovators are active information seekers about new ideas. They have a high degree of mass media exposure and their interpersonal networks extend over a wide area, usually reaching outside of their local system. Innovators are able to cope with higher levels of uncertainty about an innovation than other adopter categories. As the first to adopt a new idea in their system, they cannot depend upon the subjective evaluations of innovation from other members of their system.

Generally, technologies that were simple and low cost were among the first to be adopted by farmers. For example, permanent and temporary shade establishments; fermentation and burying of pod debris (Figures 4, 5 and 22 respectively) were among the first to be adopted.

For most of the technologies studied the diffusion curves "take off" at about 10 to 25 per cent adoption as observed by (Rogers (1993). This is after enough experiences are accumulated by farmers, especially innovators and early adopters, and exchanged within the communities. The diffusion curves begin to climb as more and more farmers adopt the technologies as interpersonal networks become activated. Over time various elements change, such as cash resources are augmented, information accumulated and experiences gained making adoption a dynamic process.

The rate of adoption of most of technologies studied was generally slow during the period MOFA carried out extension on both crops and animals. Cocoa extension never received special attention. There was non-existence of an organization, solely for cocoa, until Ghana Cocoa Board absorbed the Cocoa Services Division. The Division became the extension wing of the Board in 1973. Cocoa extension then became intensified.

Various communication channels and extension agents' promotional efforts under the Training and Visit System reflected in the high and rapid rates shown by most technologies after 1973. Government programs also influenced the rate of adoption of technologies. For example, the Cocoa Rehabilitation Program saw rapid rate of adoption of technologies involved in establishing cocoa farms from 1982, as shown by establishment of temporary shade and nurseries technologies (Figures 4 and 5). During the implementation of the Program, farmers received assistance from Cocoa Services Division in the form of nursery-raised seedlings and demonstrations on lining and pegging, free of charge for rehabilitation of burnt farms.

According to Ewusi (1998), farmers' response to the use of hybrid cocoa and new plantings increased by 72 per cent, over the three year period. This was at the beginning of the Economic Recovery and Structural Adjustment Programs. The introduction of the "High Tech" program saw a rapid rate of adoption of fertilizer application from 2002 (Figure 15). The rapid rate of adoption of fertilizer application was probably triggered by the credit incentive given to farmers under the Hi Tech program. However, if farmers adopted fertilizer application partly in order to obtain credit incentive, there is relatively less motivation to continue using the technology if the credit is discontinued.

There are variations in the slopes of the curves from technology to technology. Some technologies diffused rapidly and the curves are quite steep. Farmers perceived such innovations as possessing relative advantages. For instance, the use of hybrid cocoa, polythene bags in raising seedlings and nursery-raised seedlings as shown in Figures 7, 8 and 8 had relatively rapid rate of adoption. The degree of profitability of adoption of hybrid is higher than "Amelonado" or "Amazon" varieties. Seedlings raised in polythene bags establish in the field relatively faster and better than bare rooted seedlings. Nursery-raised seedlings also perform better in the field than seed sown at stake.

Other technologies had a slower rate of adoption and the curves are more gradual, with slopes that are relatively lazy. For instance, lining and pegging had relatively gradual slope because farmers perceived the technology as difficult to adopt. It involves cutting and conveying pegs, measuring distances and fixing pegs. Considering the mean age of farmers (56 years), it was possible that most farmers found the technology relatively difficult to adopt. The findings are consistent with views of Rogers (1983) and Dankwa (2001), who observed that the characteristics of innovations, as perceived by individuals, help to explain their different rates of adoption.

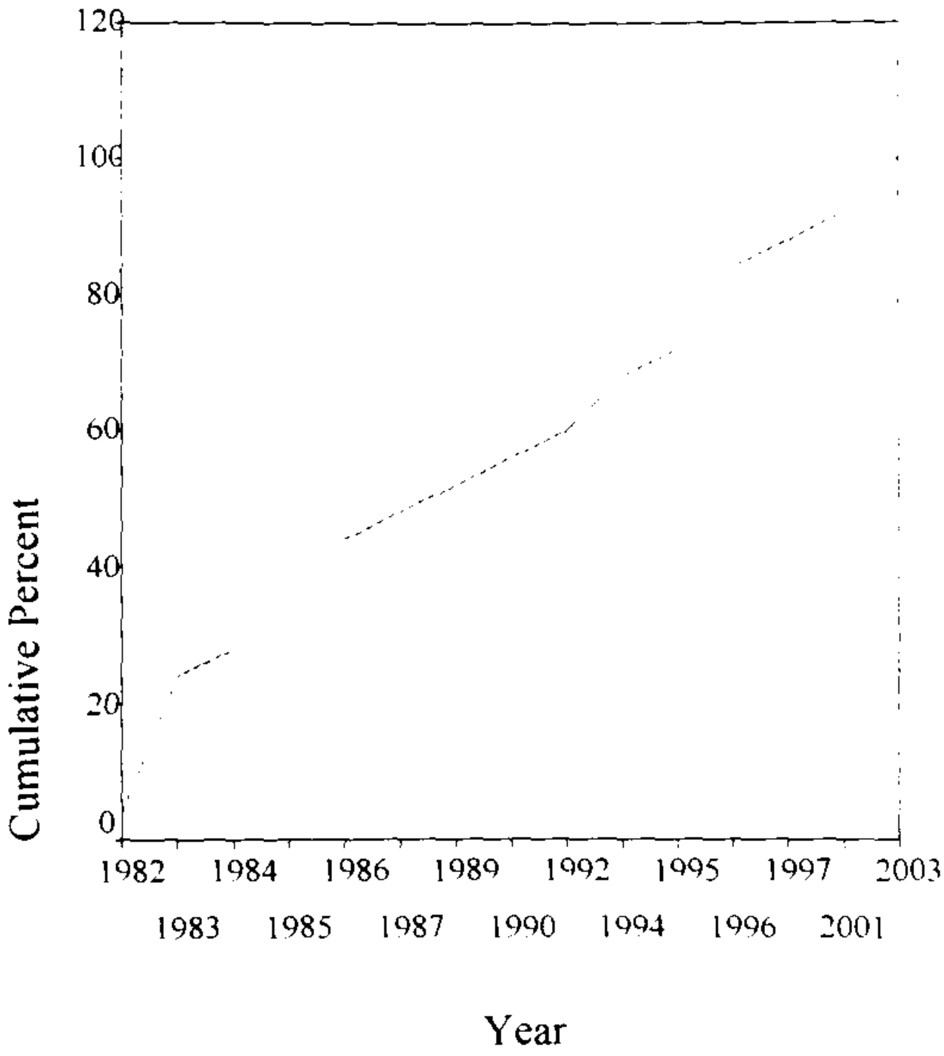

Figure 3: Adoption of Soil Test

Source: Field Data, 2004

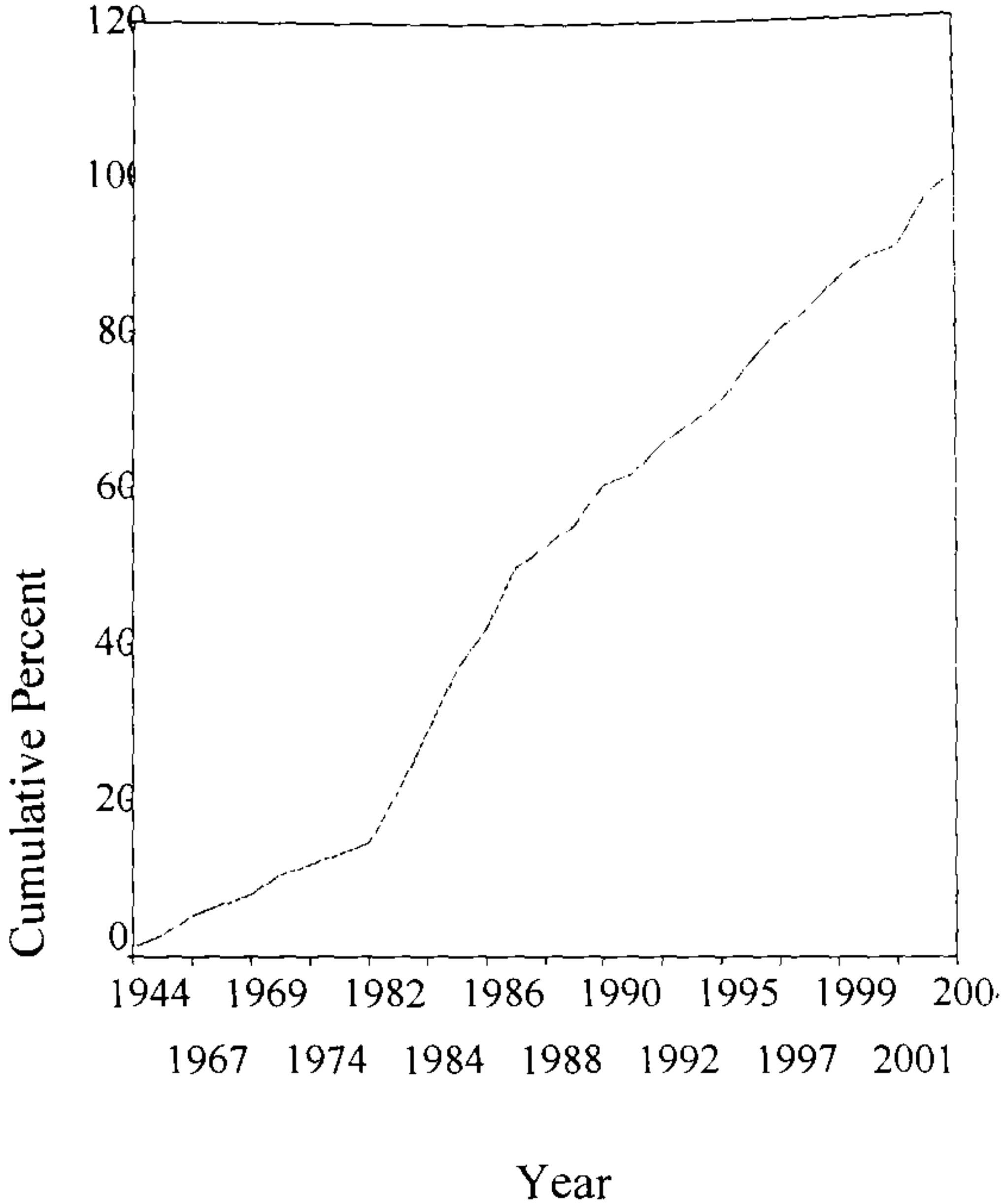

Figure 4: Adoption of Temporary Shade

Source: Field Data, 2004

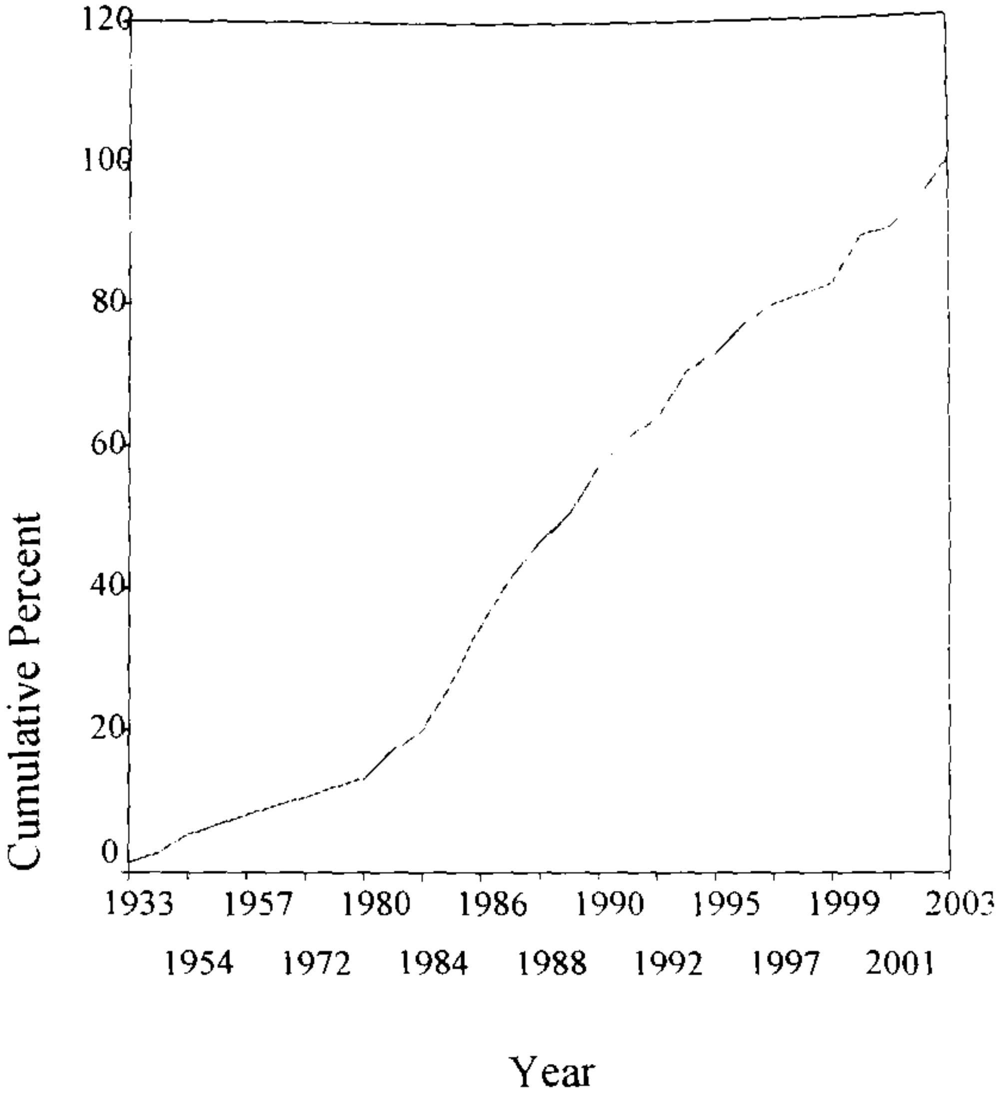

Figure 5: Adoption of Permanent Shade

Source: Field Data, 2004

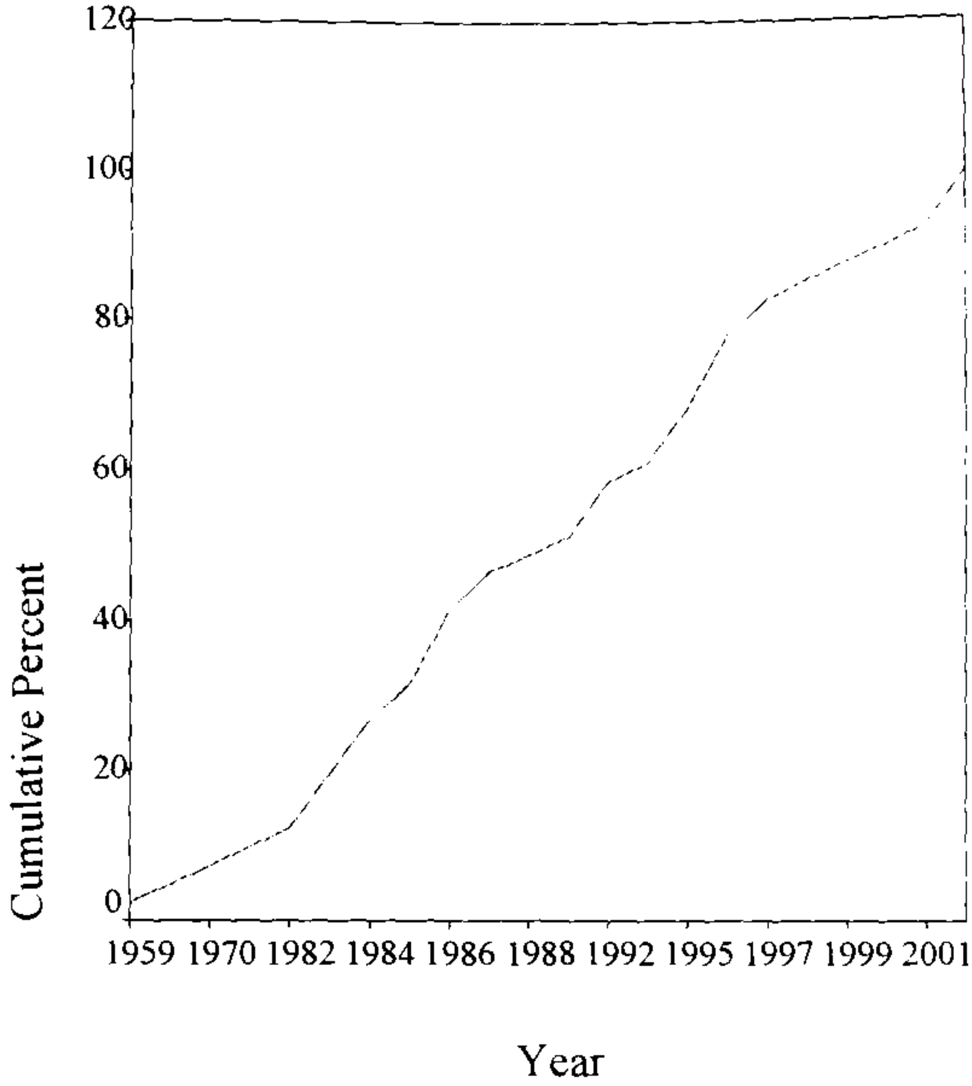

Figure 6: Adoption of Line and Pegging

Source: Field Data, 2004

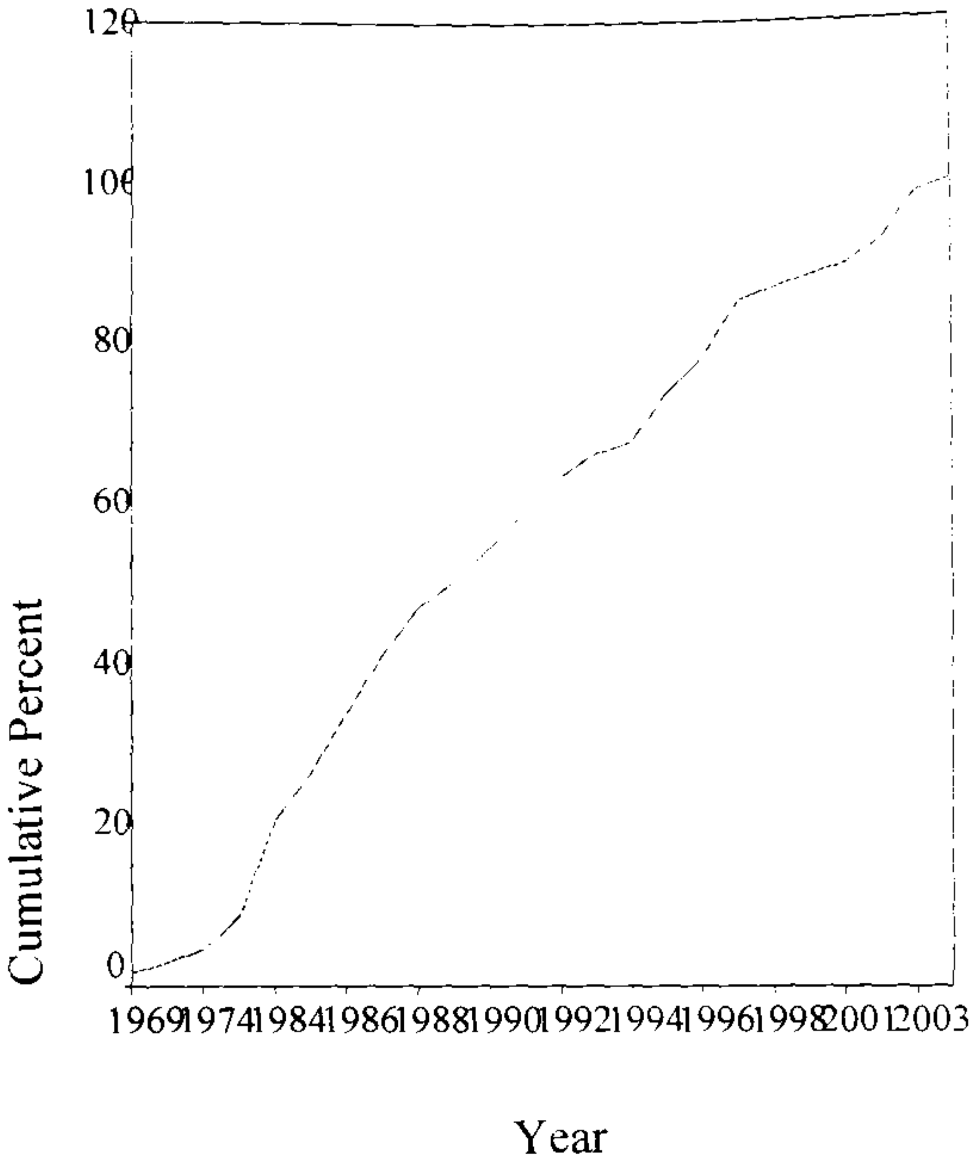

Figure 7: Adoption of Hybrid

Source: Field Data, 2004

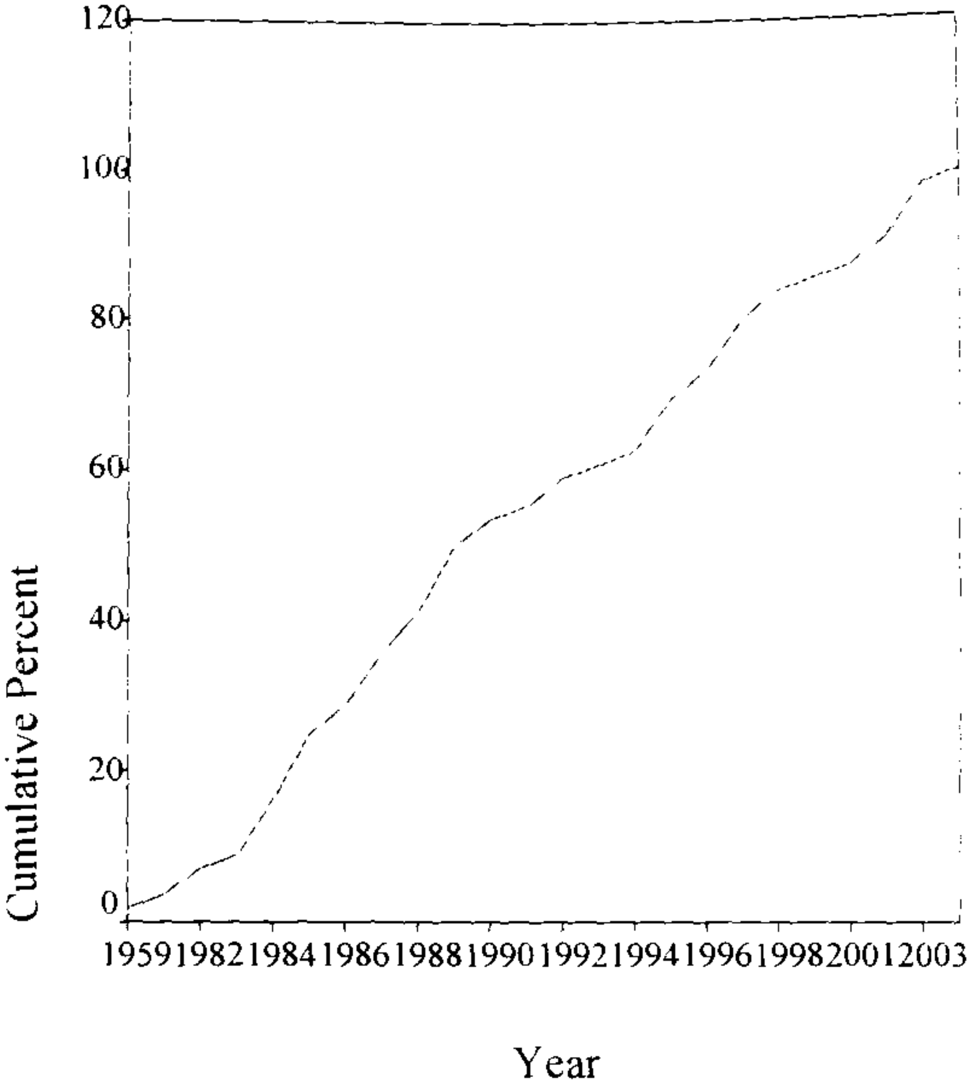

Figure 8: **Adoption of Nursery-raised Seedlings**

Source: Field Data, 2004

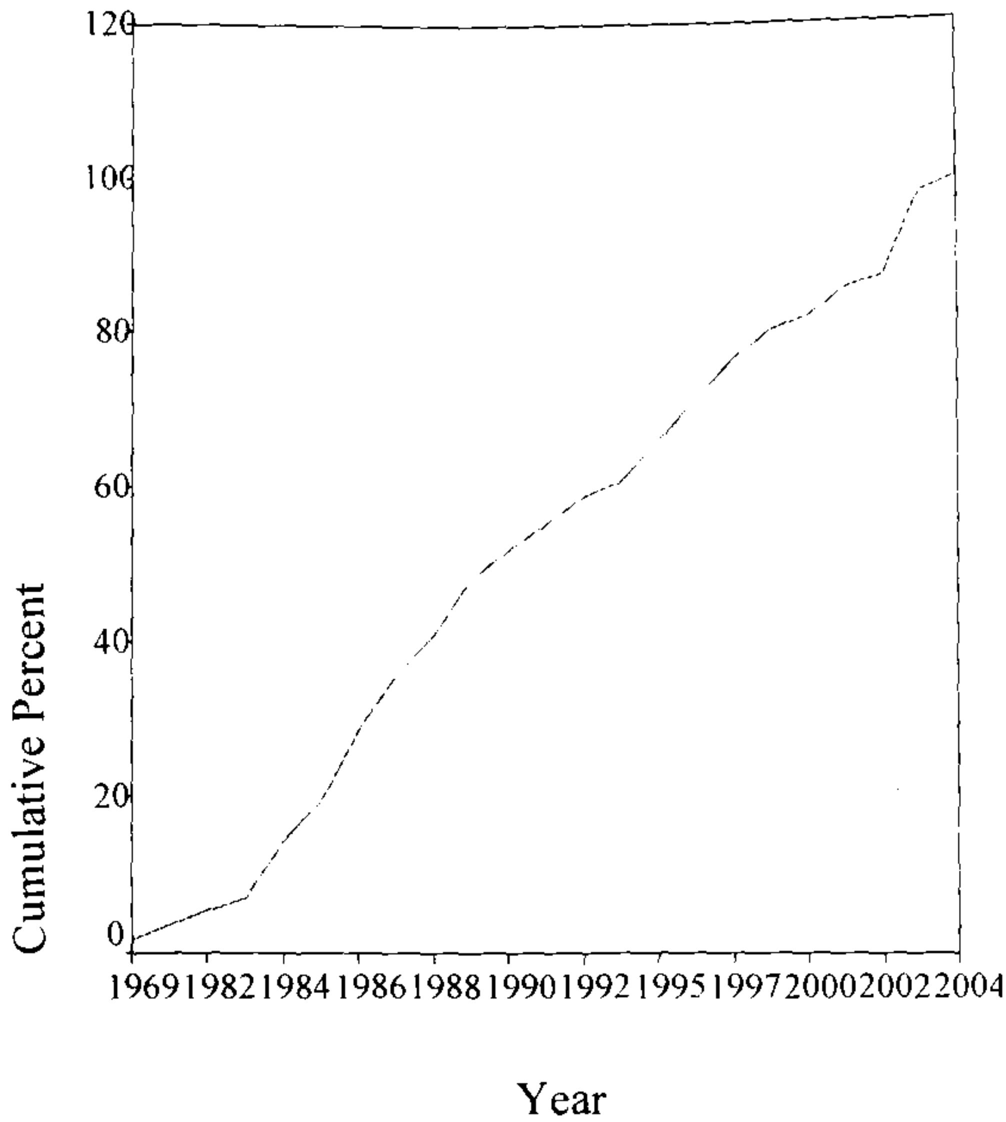

Figure 9: Adoption of Seedlings Raised in Polythene Bags

Source: Field Data, 2004

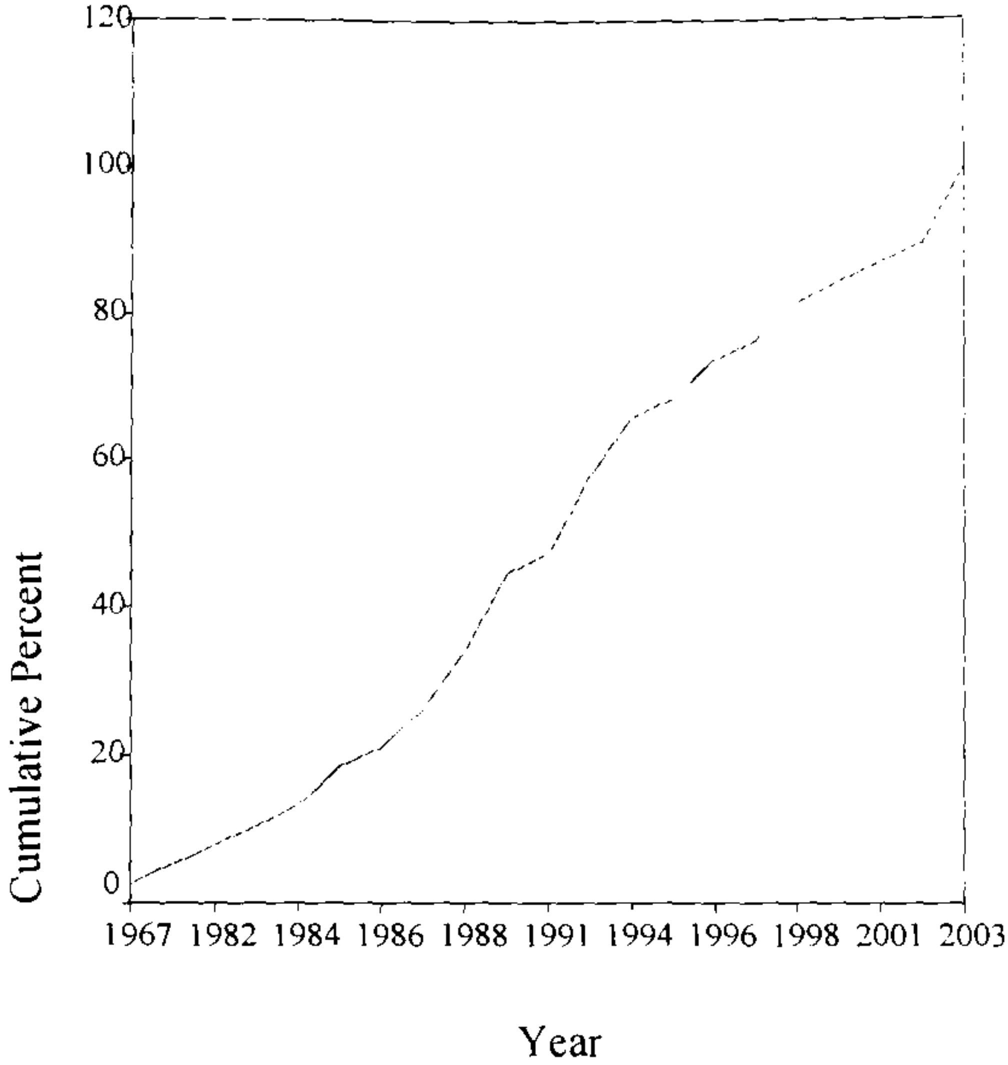

Figure 10: Adoption of Optimum Crop Density

Source: Field Data, 2004

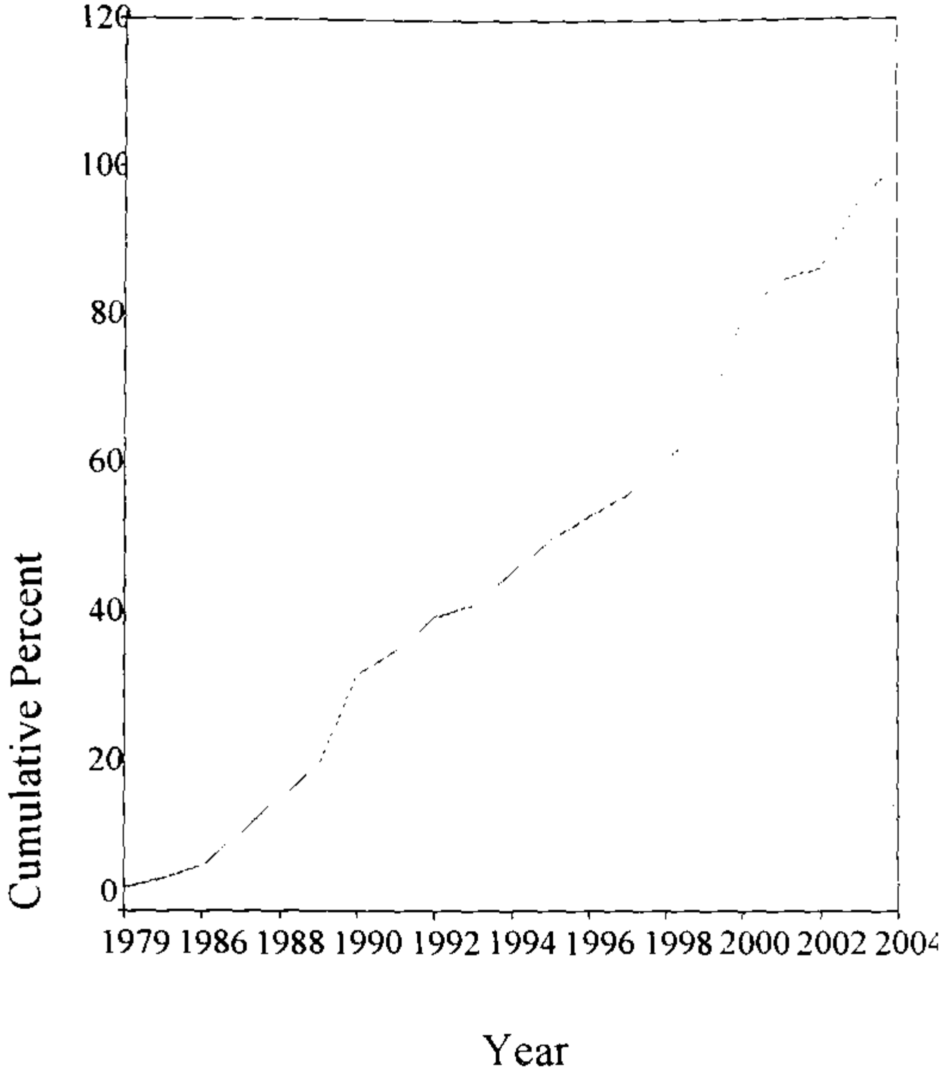

Figure 11: Adoption of Shade Manipulation

Source: Field Data, 2004

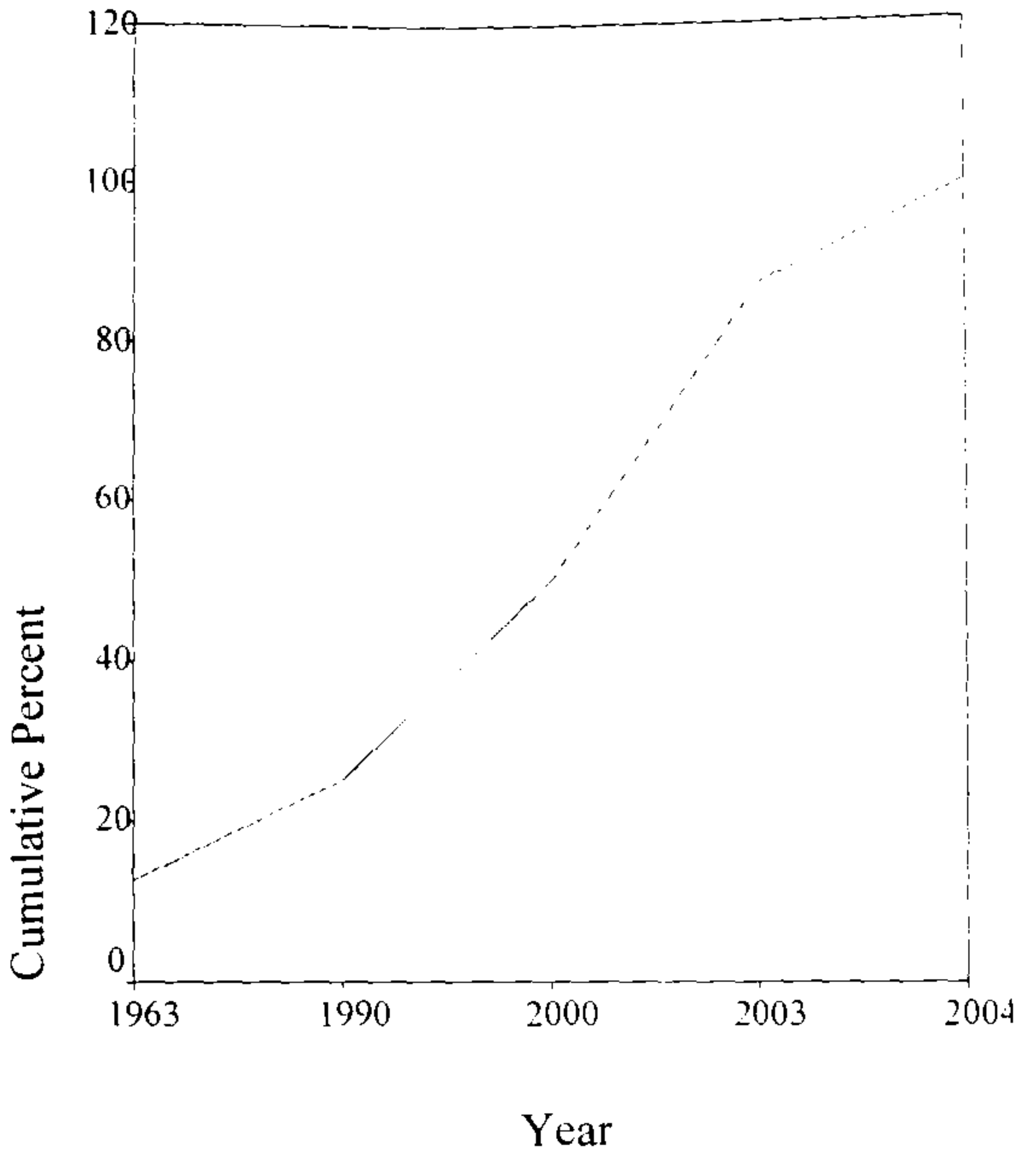

Figure 12: Adoption of Herbicide Application

Source: Field Data, 2004

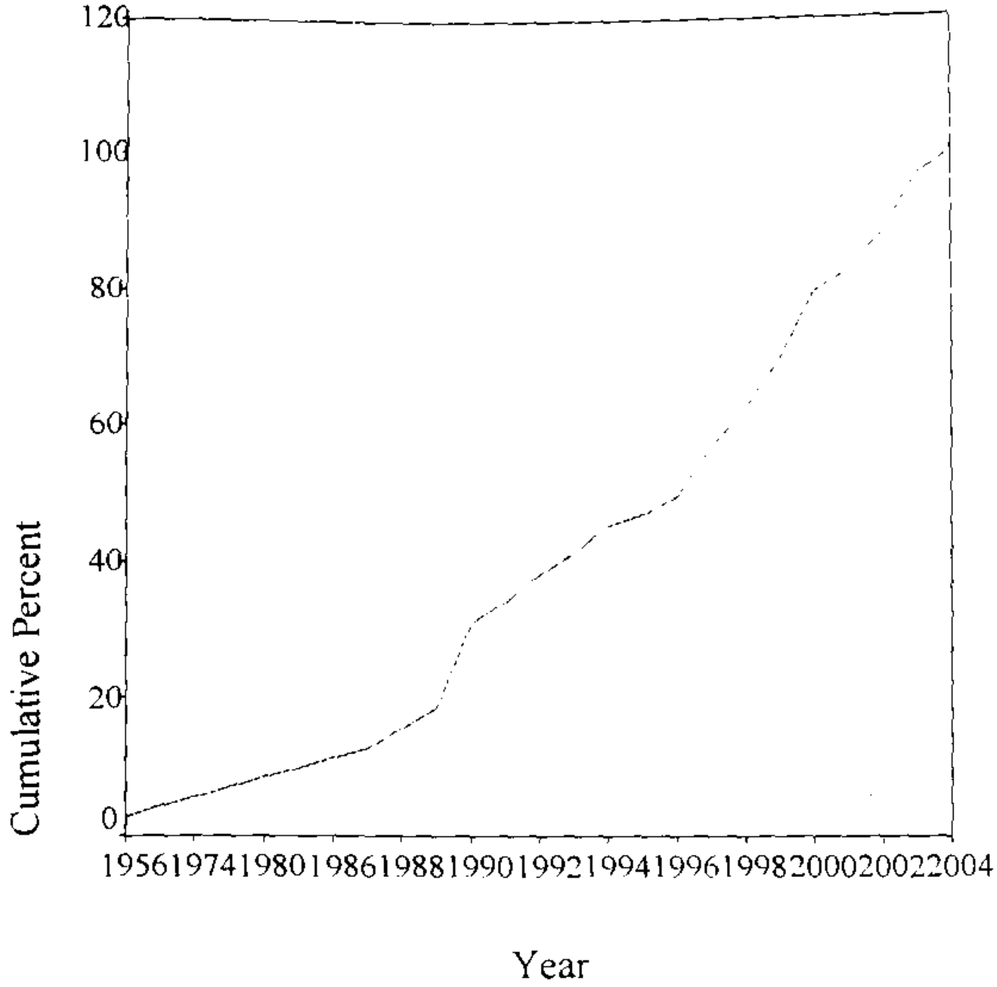

Figure 13: Adoption of Pruning

Source: Field Data, 2004

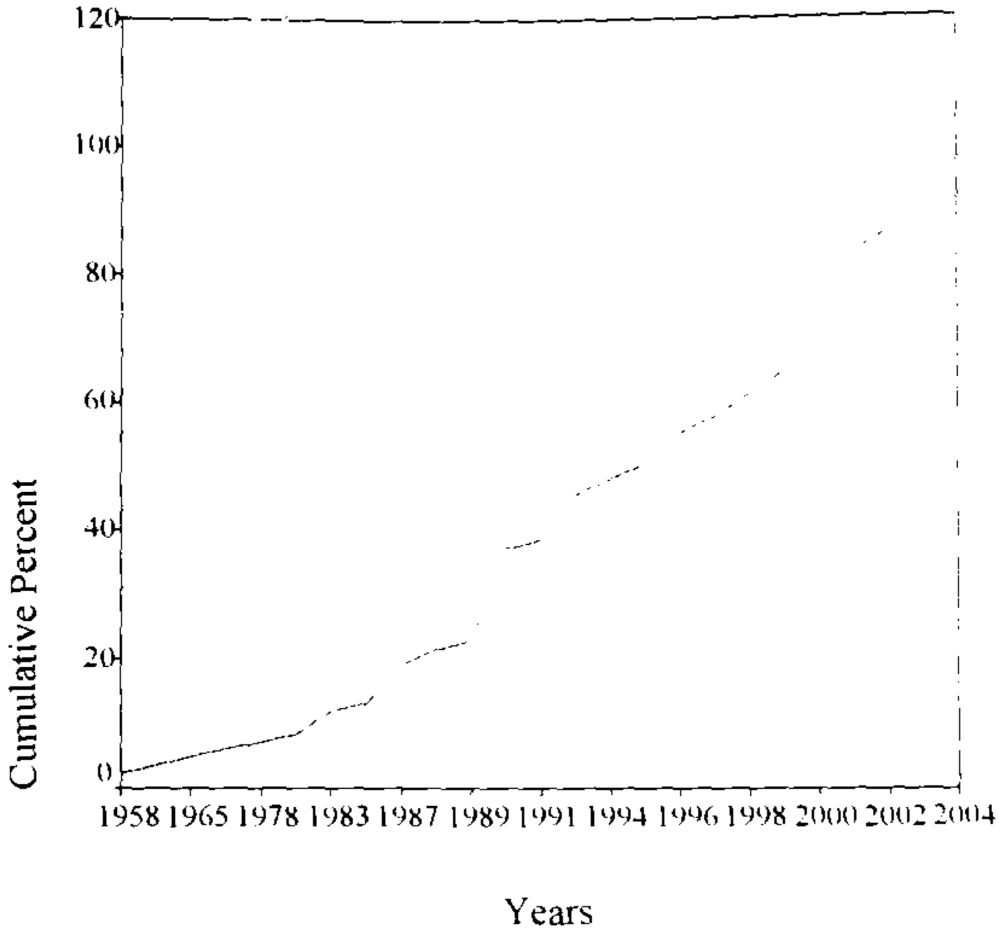

Figure 14: Adoption of Removal of Chupons

Source: Field Data, 2004

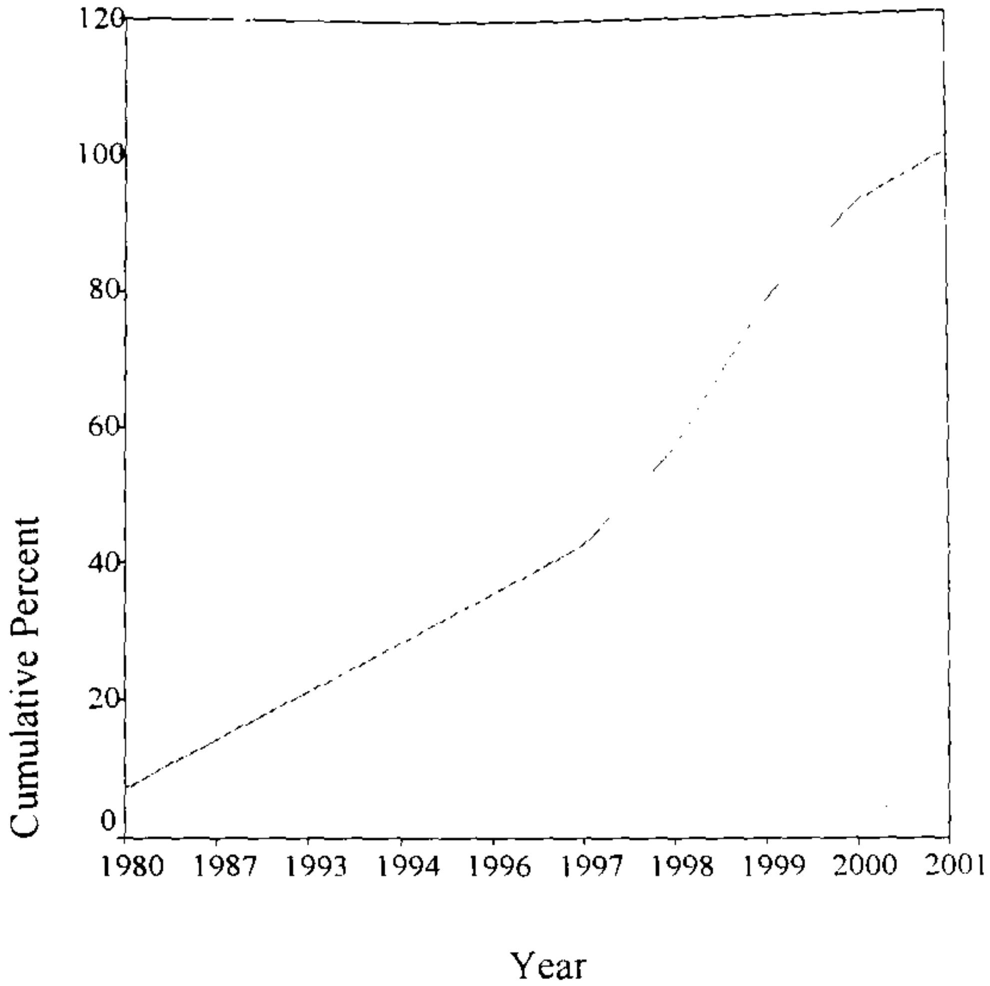

Figure 15: Adoption of Pruner

Source: Field Data, 2004

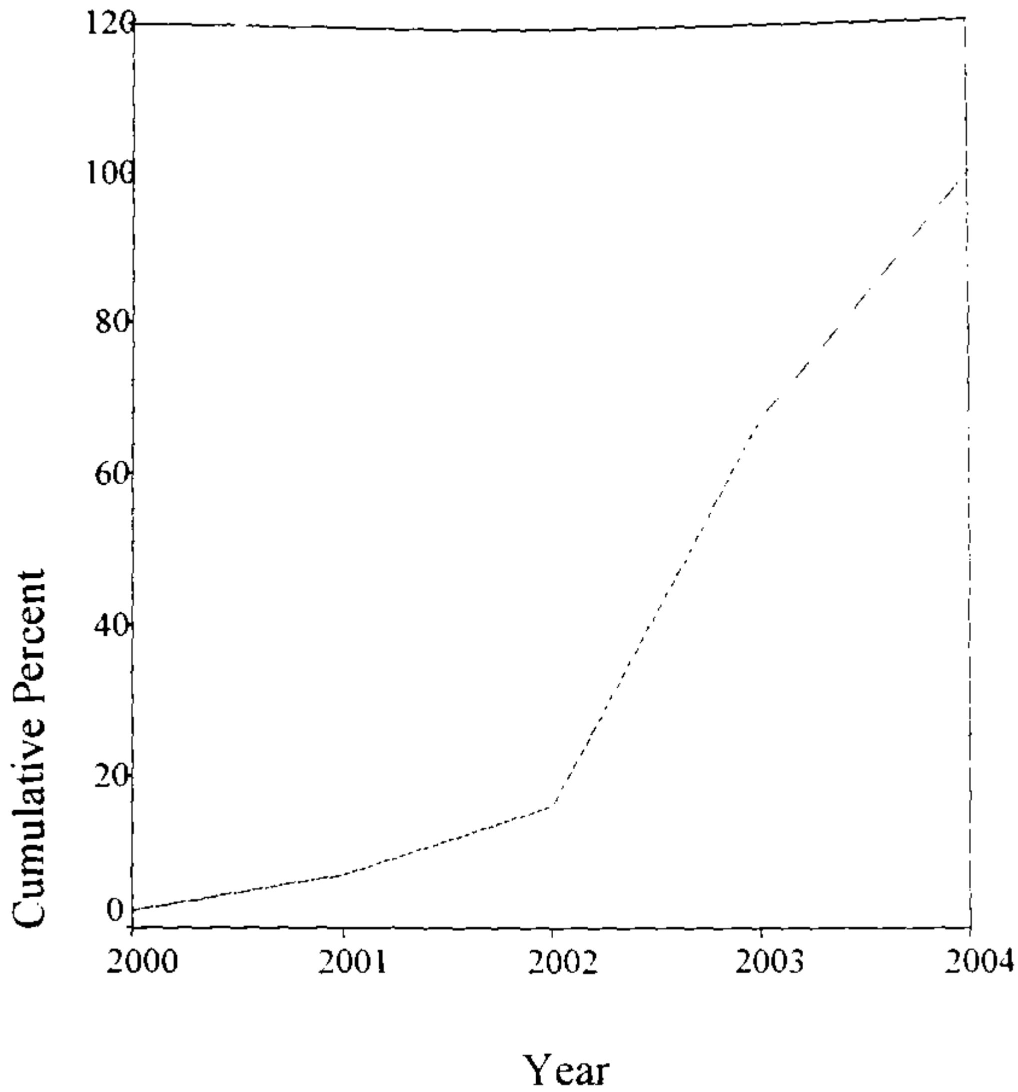

Figure 16: **Adoption of Fertilizer Application**

Source: Field Data, 2004

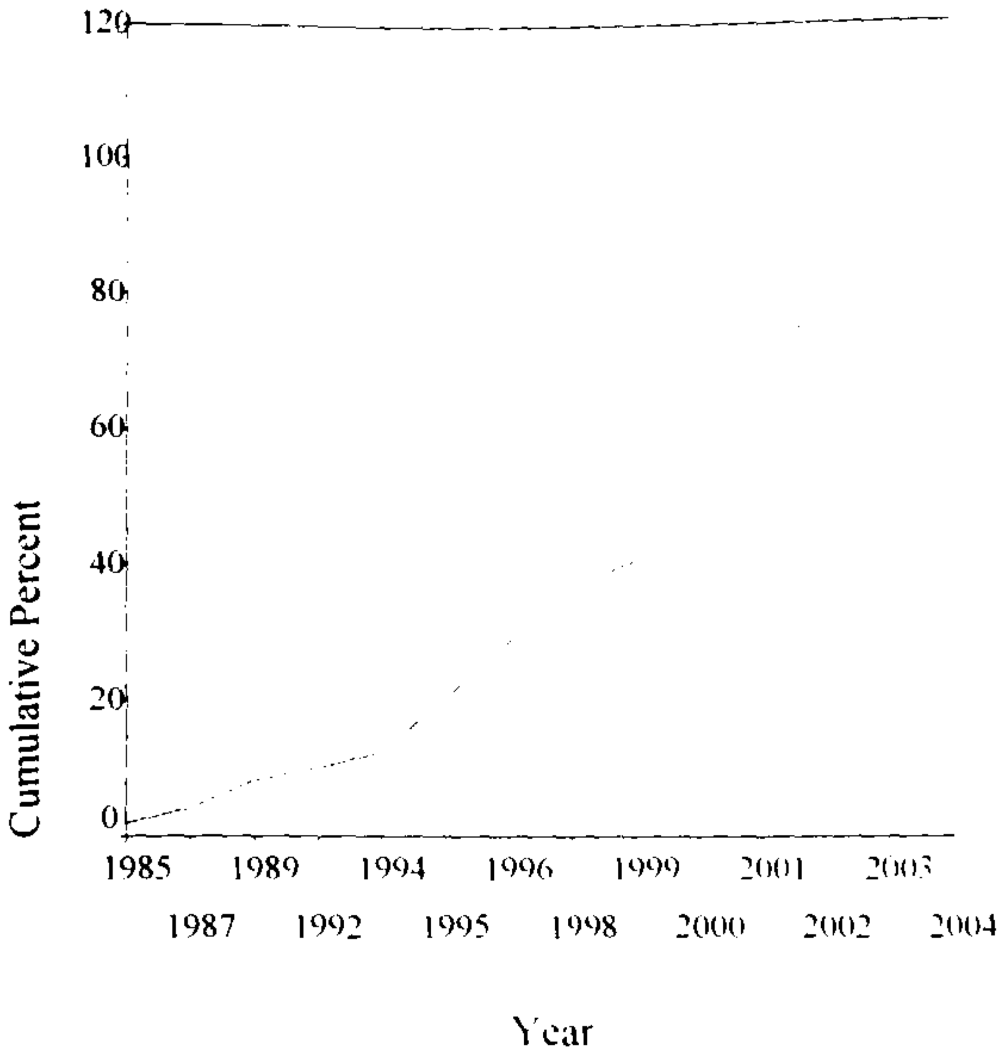

Figure 17: Adoption of Insecticides

Source: Field Data, 2004

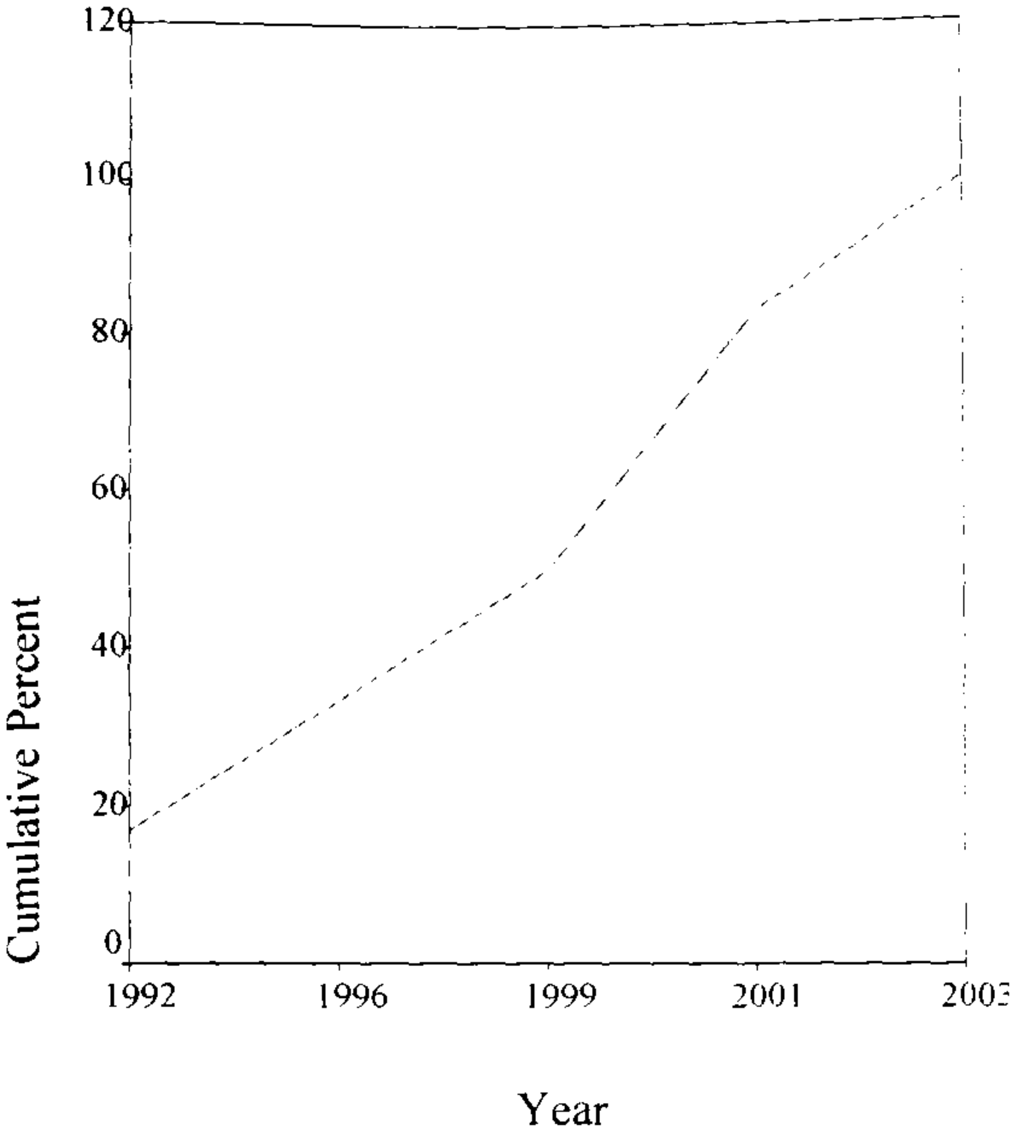

Figure 18: Adoption of Adequate Drainage

Source: Field Data, 2004

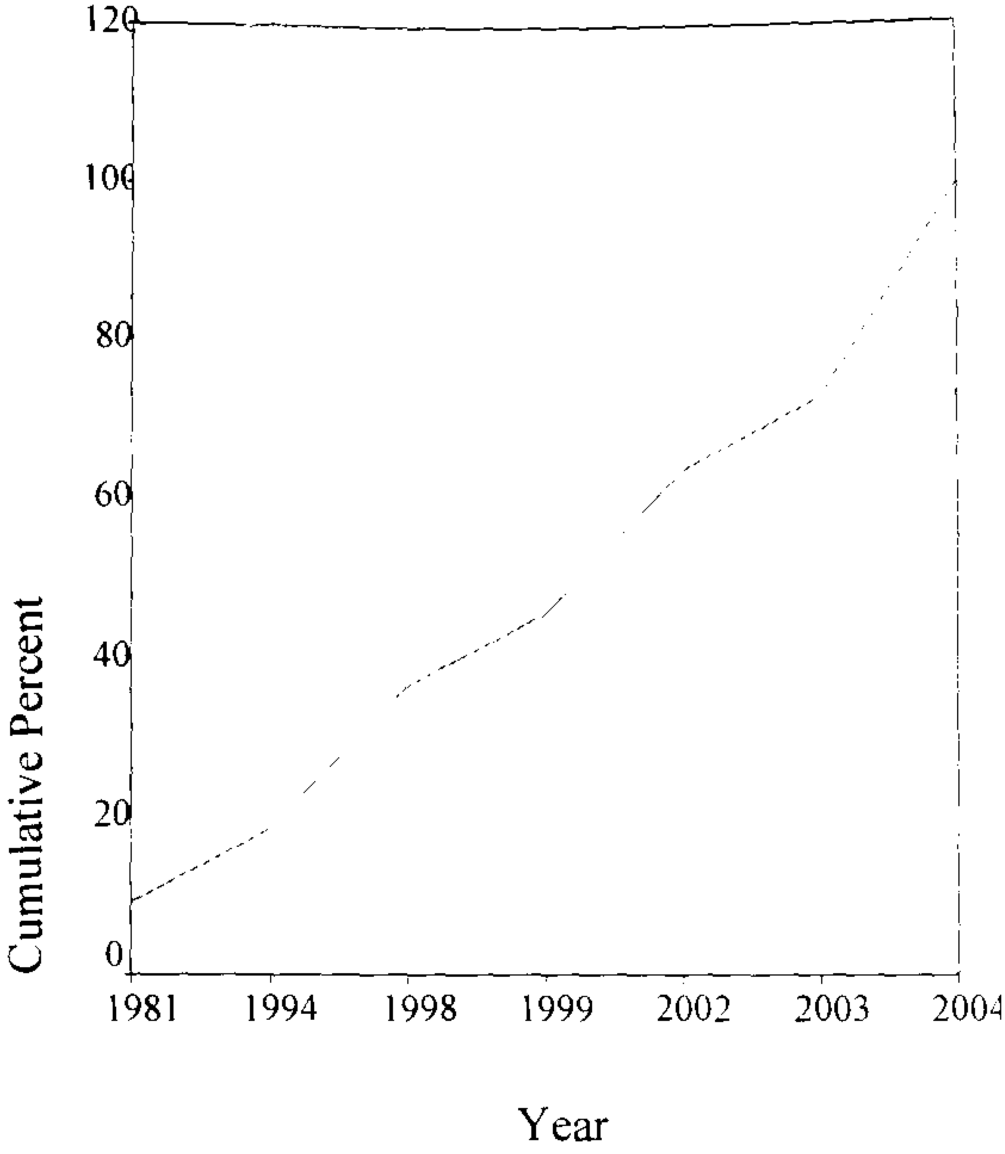

Figure 19: Adoption of Swollen Shoot Virus Disease Control

Source: Field Data, 2004

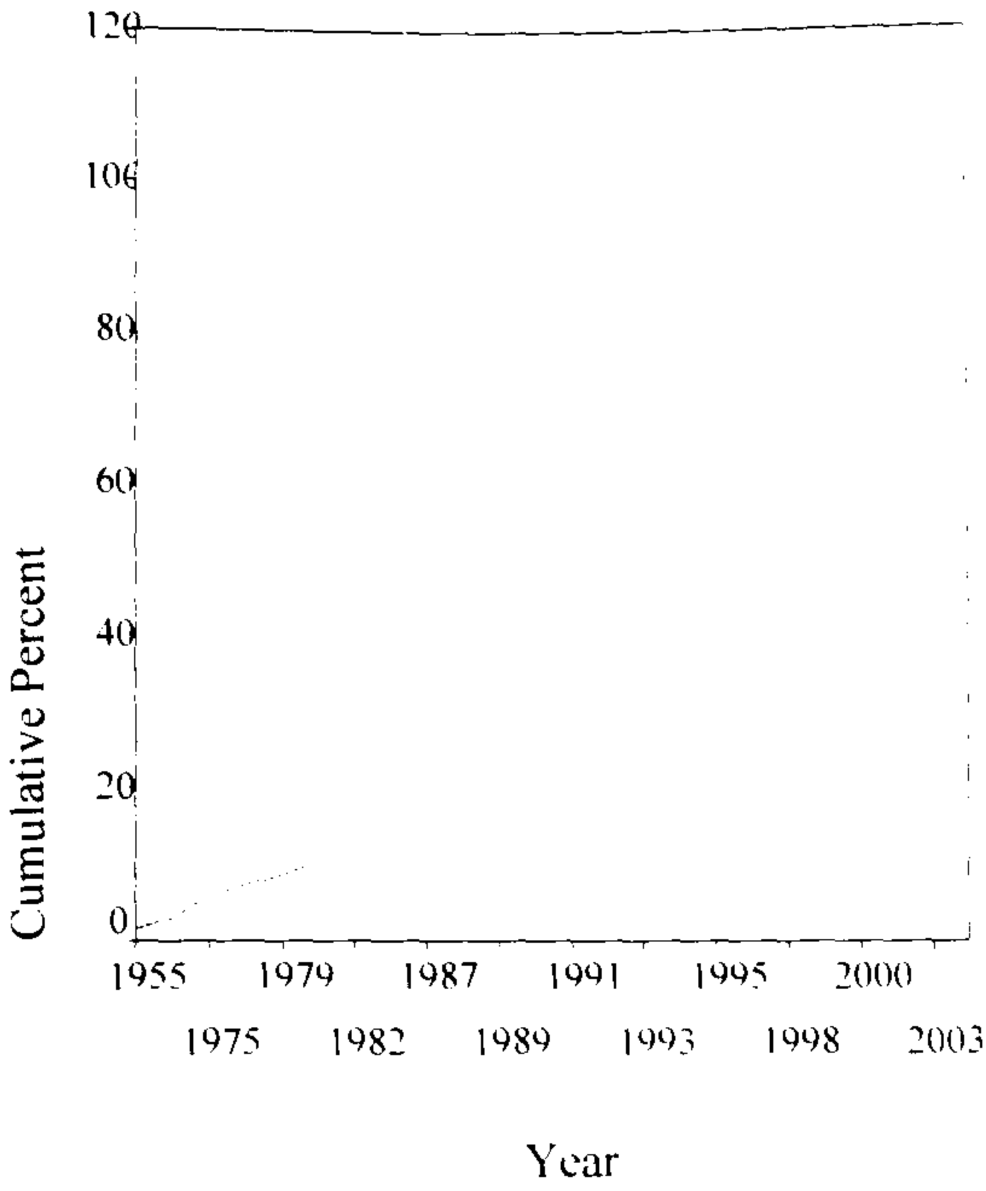

Figure 20: Adoption of Pod Debris Burial

Source: Field Data, 2004

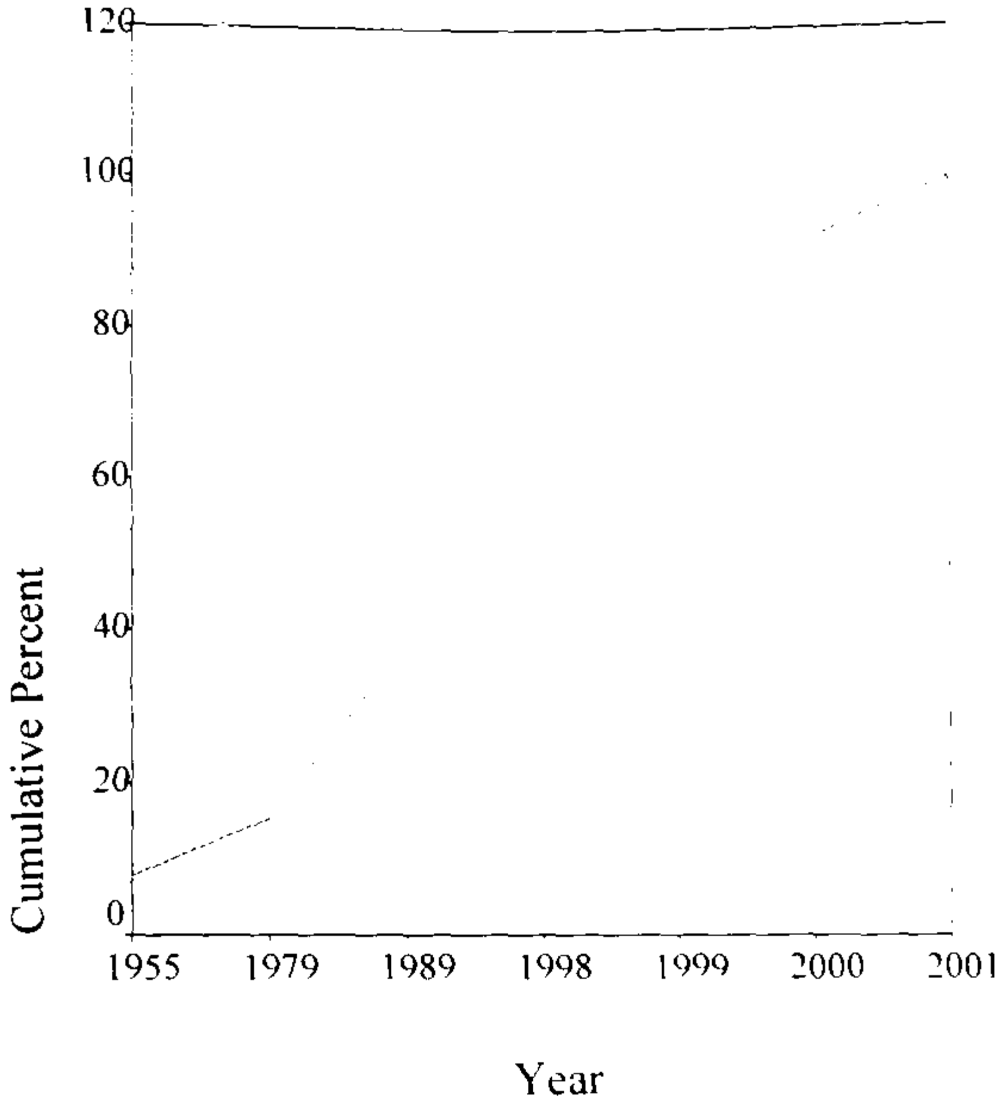

Figure 21: Adoption of Regular Harvest

Source: Field Data, 2004

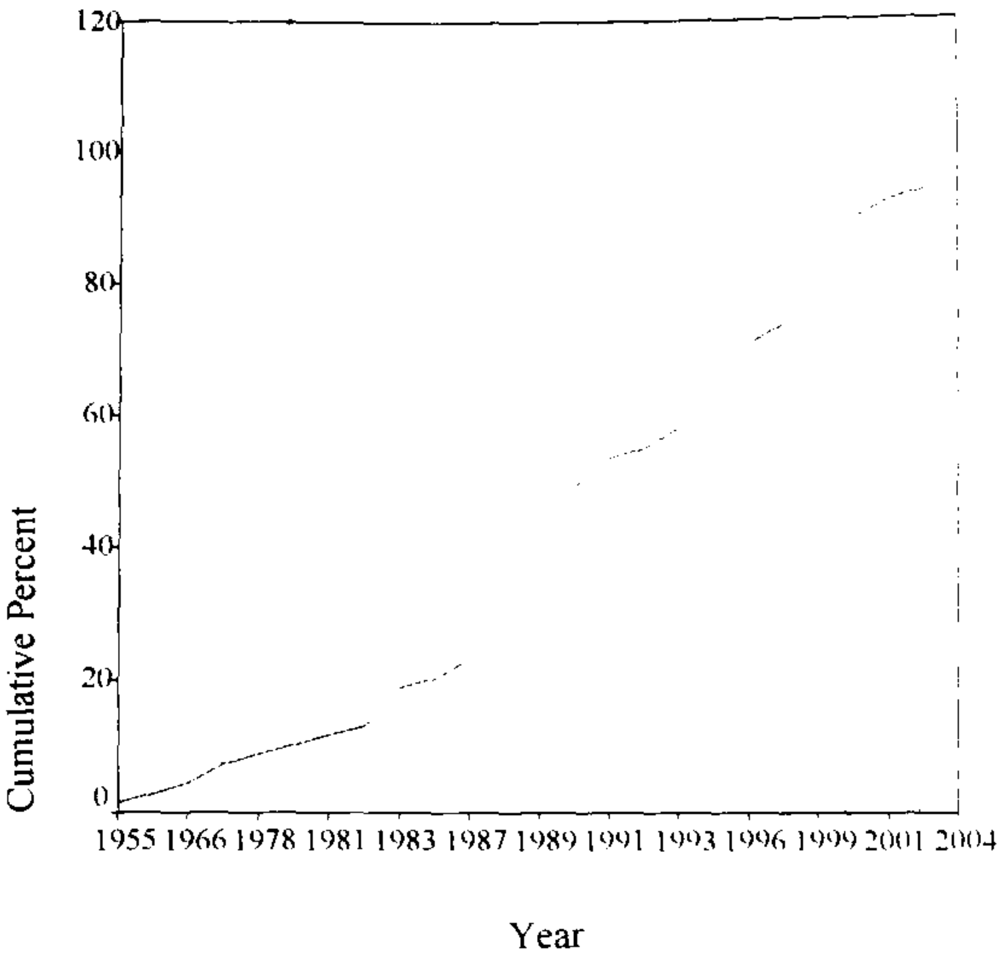

Figure 22:

Adoption of Fermentation

Source: Field Data, 2004

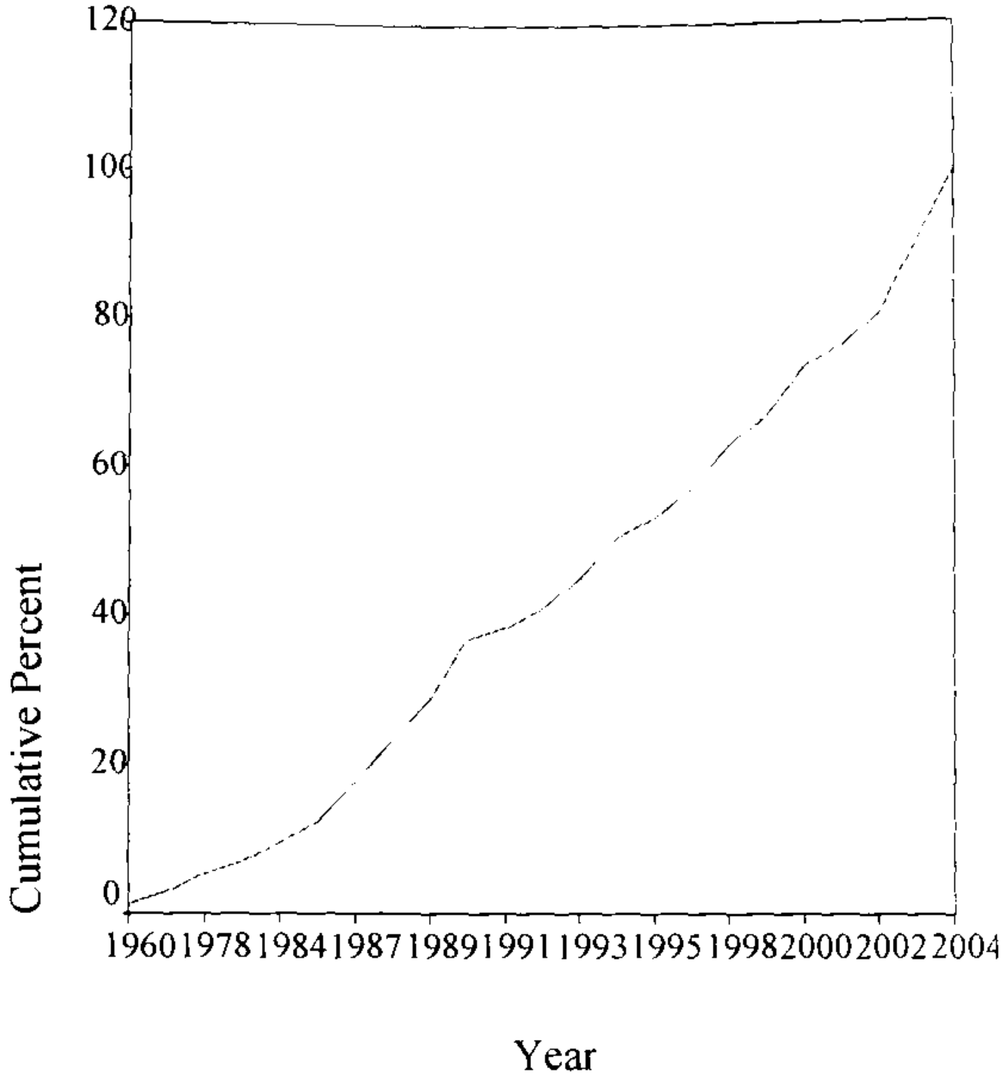

Figure 23: Adoption of Stirring of Beans During Fermentation

Source: Field Data, 2004

The next section deals with the percentage of farmers who adopted the various technologies

Pre-Planting Technologies

These include soil test, lining and pegging, optimum crop density, row spacing, temporary shade and permanent shade. Even though majority of farmers considered the soil type in choosing the sites for their farms, soil test received low rate (16.4 %) of adoption by farmers as shown in Figure 24. Soil test involves digging profile pits and analyzing the texture, structure, pH etc. Farmers perceived it to be a complex technology. Most farmers lacked knowledge of conducting soil test. Other reasons given by farmers for not conducting soil test were lack of awareness of the importance of soil test and the belief that soil analysis was not necessary. Other farmers could not afford the cost involved in the test. The extension service can do well to create the awareness and educate farmers on the importance of soil analysis for higher productivity.

Majority of farmers (51.4 %) adopted line and pegging method of planting. Lining and pegging ensures accurate and appropriate planting distance. Minority of farmers (48.6 %) adopted optimum crop density. This is not surprising. Optimum crop density requires a change from the traditional inter-cropping system, which provides supplementary income, during initial stages of the plantation, to one of pure stand of cocoa only.

Row spacing also attracted low rate (36.7 %) of adoption because farmers perceived the practice as tedious, complex, and time consuming. Most farmers (73.4 %) adopted temporary shade because of its relative advantage. It is simple to adopt. Food crops, which give the farmer an initial income from the land prepared for the plantation, serve as temporary shade. Farmers frequently planted plantain, banana, cocoyam, cassava and vegetables. Temporary shade also acts as a windbreak. Establishing essential temporary shade ensures that the exposed soil does not become degraded by direct exposure to the growing trees.

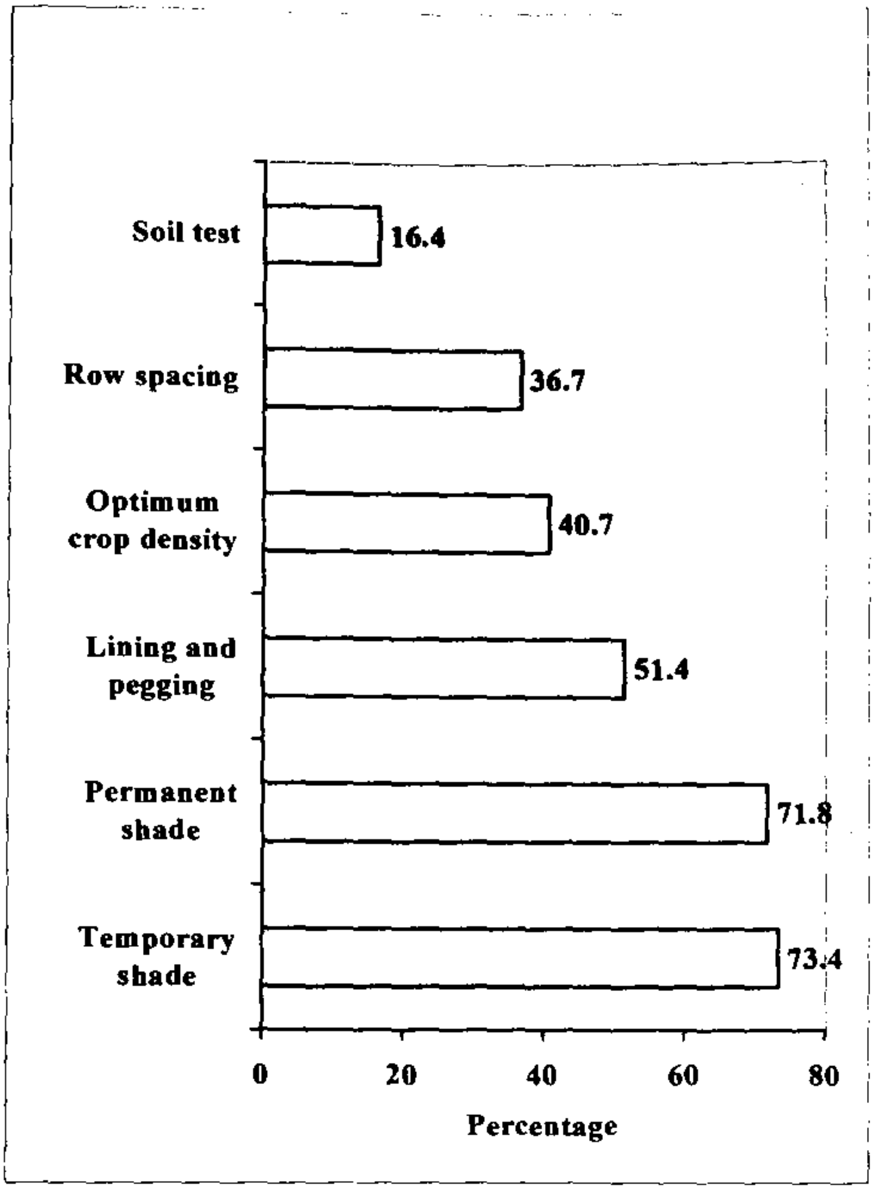

Figure 24 Rate of Adoption of Planting Technologies

Source: Field Data, 2004

Nearly 72 % of farmers adopted permanent shade by retaining 6-15 trees per hectare. Establishing permanent shading is intended to form a canopy over the adult plantation. Permanent shading is also simple to adopt. However, permanent shading may be unnecessary provided soil fertility and other prevailing conditions are favorable. According to Padi and Owusu

(2003), traditionally in West Africa, cocoa shade relates to the density of forest trees left in the field after the initial clearing of the forest. Growing cocoa under shade stems from the belief that cocoa, being a second storey tree, thrives best under heavy forest shade. However, with the exploitation of forest trees for timber and other purposes, it has become necessary to plant alternative fast growing tree species to provide shade. Thus cocoa cultivation is of great importance for the conservation of the forest and associated fauna in Africa.

Few farmers did not retain any forest tree as permanent shade. A study on the levels of permanent shade in cocoa farms in Ghana and Cote d'Ivoire by Freud, Petithuguenin and Richard (in press) showed that about 50 % of the total cocoa area in both countries was under mild shade whilst an average of about 10 % and 35 % in Ghana and Cote d'Ivoire, respectively, was under no shade. Thus, there is a gradual but sure move towards eliminating shade trees. This, combined with timber-related and other activities, is gradually causing the deterioration of the forest and its rich flora and fauna.

Nursery Technologies

The rates of adoption of nursery technologies appear in Figure 25. These technologies include hybrid variety, seedlings raised in polythene bags, and nursery raised seedlings. Most farmers (66 %) adopted hybrid-planting material. Farmers adopted hybrid because of the relative advantages it has. For instance, compared with *Amelonado* or *Amazon* varieties, the hybrid variety is more vigorous, precocious, and higher yielding. In addition, the size and bean quality of the hybrid are better. It is also more resistant to diseases and pests.

Seedlings raised in polythene bags attracted 55.9 % rate of adoption by farmers. The main reason for farmers' adoption is that polythene bags ensure that the roots are less disturbed for better establishment in the field. Majority of farmers (57.6 %) adopted nursery-raised seedlings. This is because according to Mossu (1992), there are many points in favor of sowing seeds in the nursery, as opposed to directly out in the field as shown in Table 21

Table 21: Sowing Seed in the Nursery or Out in the Field

Advantages of the nursery-raised seedling	Disadvantages of direct sowing
It saves time. While the plants are being raised in the nursery, the ground can be prepared in the plantation.	Very high cost of seeds.
Protection of and monitoring the health of the young plants to ensure that the best period can be selected.	Many uncontrollable attack (insects, rodents) and frequent destruction of the young plants when the plot is being weeded.
Watering guaranteed.	Water requirements subject to the vagaries of the climate.
The best planting period can be selected.	

Source: Mossu (1992)

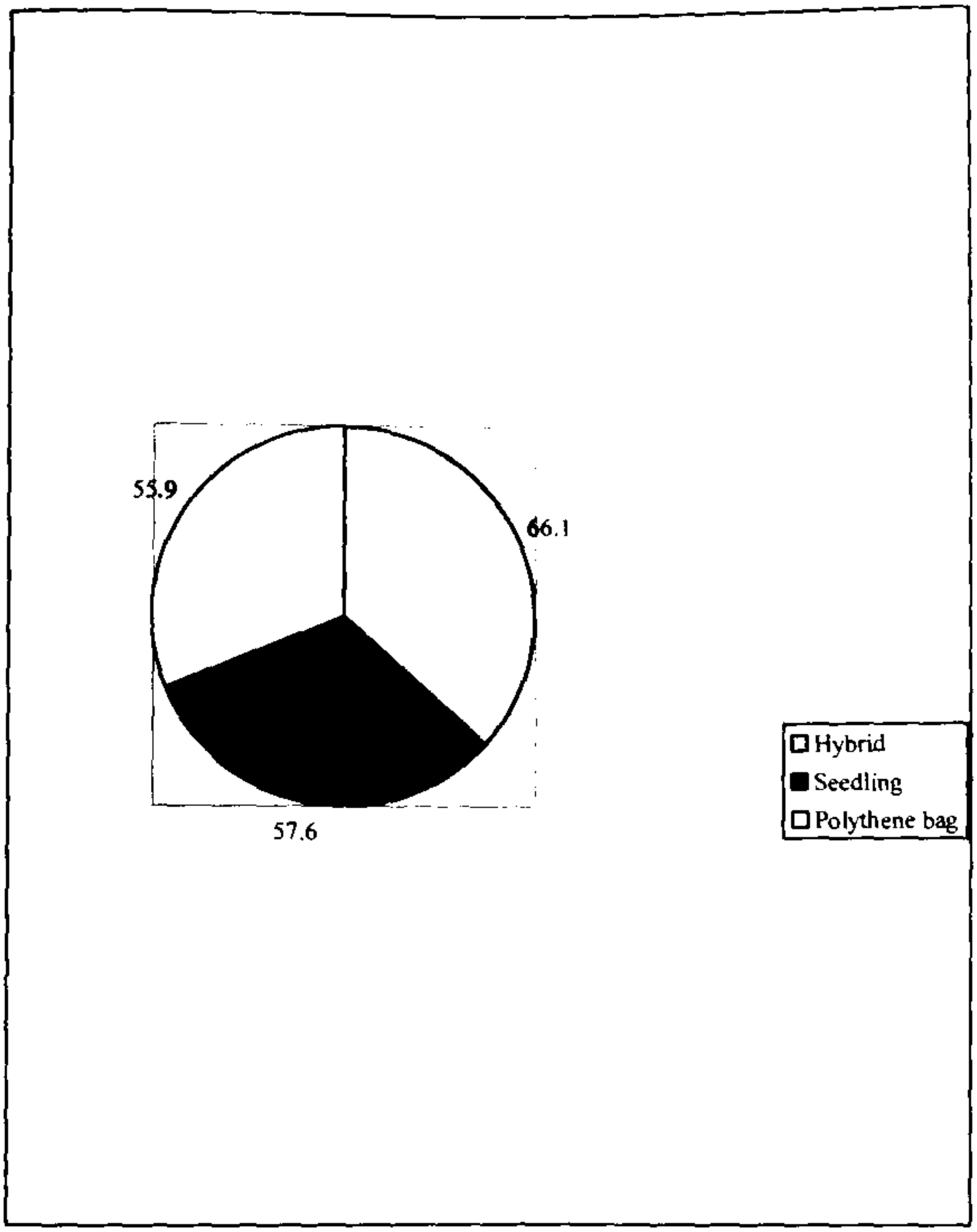

Figure 25 Rate of Adoption of Nursery Technologies

Source: Field Data, 2004

Technologies Involved in Maintenance of Farms

Technologies involved in maintenance of farms include regular weeding, pruning and shade manipulation. The rest are removal of basal chupons, swollen shoot control, provision of adequate drainage and use of pruner The rates of adoption of these technologies are shown in Figure 26. The rate of adoption of regular weeding was 77.4 %. The reason why majority of farmers weeded regularly was that weeding is an important operation in maintaining cocoa farms. Regular weeding ensures good crop. However, Anon (1995) observed that only one-third of farmers interviewed in a nation-wide survey in Ghana in 1991-1993 weeded their farms adequately (i.e. 3-4 times a year as recommended).

Pruning is the removal of unwanted growth or parts of the plant. The rate of adoption of pruning was 66.1 per cent. Majority of farmers adopted pruning because it gives shape to the trees and helps in farm operations. Pruning also improves free airflow and opens the canopy to allow light to penetrate the farm. Pruning reduces the incidence of black pod disease. The rate of adoption of shade manipulation was 62.1 per cent. Majority adopted shade manipulation because of the relative advantages involved. For example, shade manipulation reduces the incidence of diseases. It also allows more or less sunlight as required to penetrate the farm. Majority of farmers (81.4 %) adopted the removal of unwanted basal chupons. Generally, this technology is simple to perform. It also ensures the sturdy growth of the tree resulting in improved yield.

The rate of adoption of swollen shoot virus disease control was 14.1 per cent. The low adoption rate was presumably, because the trees were still producing pods (control is by uprooting the whole tree and other trees in contact with it). Farmers and the nation need the pods for obvious reason of more revenue. Majority of farmers mentioned that swollen shoot disease did not occur on their farms. In addition, 32 per cent of farmers did not know or pruner. The rates of adoption of these technologies are shown in Figure 26. The rate of adoption of regular weeding was 77.4 %. The reason why majority of farmers weeded regularly was that weeding is an important operation in maintaining cocoa farms. Regular weeding ensures good crop. However, Anon (1995) observed that only one-third of farmers interviewed in a nation-wide survey in Ghana in 1991-1993 weeded their farms adequately (i.e. 3-4 times a year as recommended).

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The rate of adoption of provision of adequate drainage was low. Less than ten per cent of farmers provided adequate drainage to control black pod disease. It could be that the provision of drainage was not a major problem facing most farmers. Only 22 per cent of farmers used pruners in controlling mistletoes in their farms. This supports the finding of Asante-Mensah (1988), who noted that about 87 % of non-adopters lacked pruners. Extension workers need to promote acquisition of pruners for higher adoption since it is easier and more effective to control mistletoes with pruners

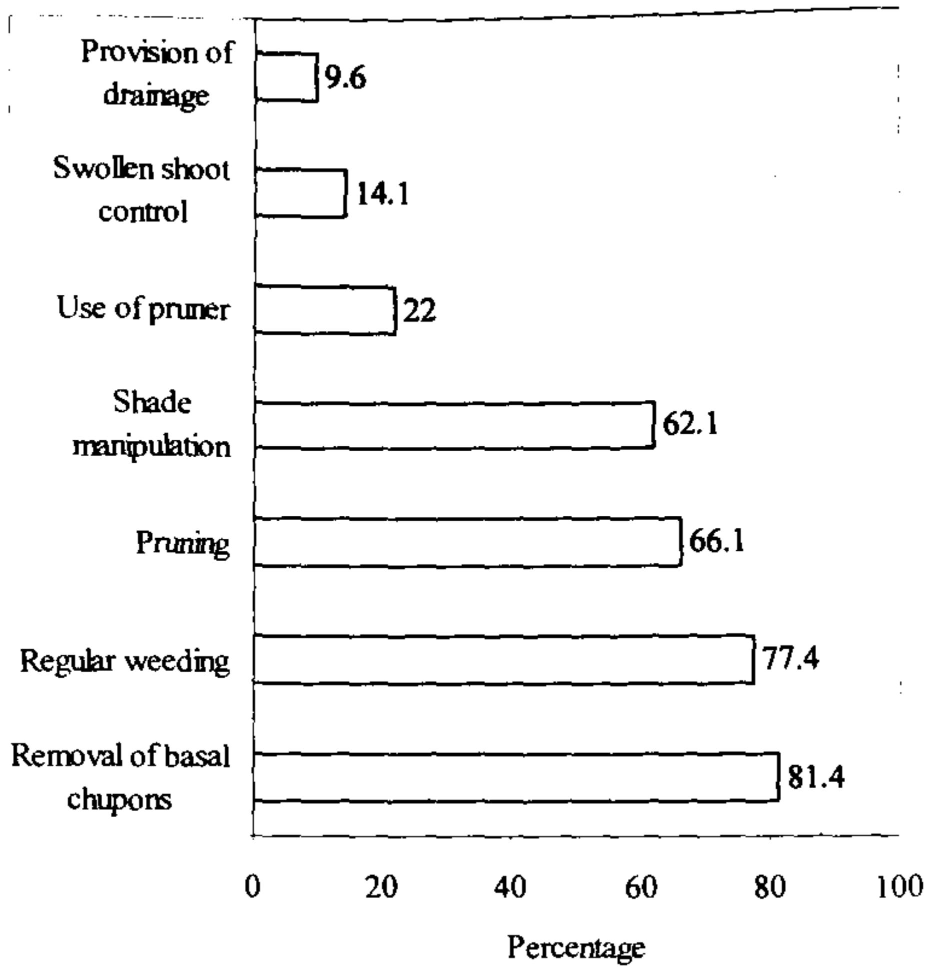


Figure 26 Rate of Adoption of Technologies Involved in Farm Maintenance

Source: Field Data, 2004

Chemicals Application

Figure 27 shows that the adoption rates of chemicals application by farmers. The chemicals include insecticides, fungicides, fertilizers and herbicides. The use of insecticides attracted nearly 77 per cent rate of adoption by farmers. This confirms results of Vigneri (2004), who noted that insecticide use increased substantially. The high rate of adoption of insecticides points to the success story of the cocoa pests control program instituted by the Government. Most farmers perceived this technology, as highly profitable, since the devastating effects of capsids and other pests on cocoa could be alarming.

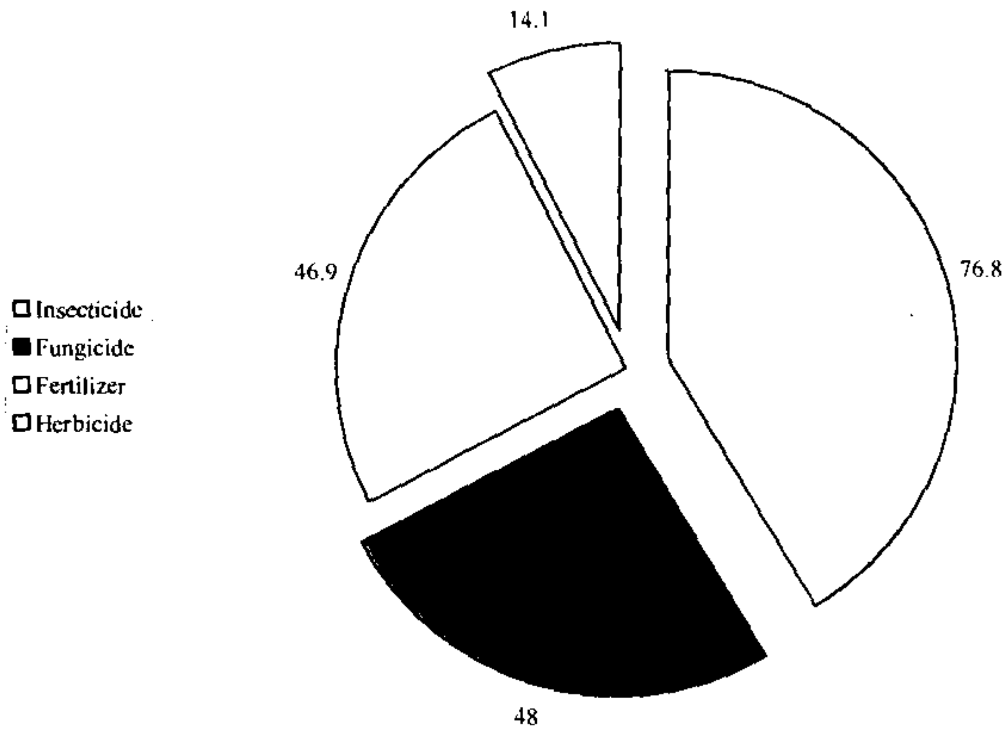


Figure 27 Rate of Adoption of Chemicals Application

Source: Field Data, 2004.

The use of fungicides attracted 48 per cent rate of adoption by cocoa farmers. On the contrary, about 54.4 per cent of farmers adopted this technology as noted by Dankwa (2001). Asante-Mensah (1988), also found that the use of fungicides for the control of diseases received low rate of adoption. Reasons for the low rate of adoption included lack of knowledge on the use of fungicides. About 25% of farmers did not encounter any Black Pod disease on their farms. Most farmers felt that the repetitive applications (three-weekly sprays over six month period) were costly and cumbersome to adopt. The majority of farmers either does not spray their farms at all, or do only one or two applications instead of the recommended 6-7 applications per year for black pod control, thus incurring heavy crop losses every year (Henderson, Asante, Donkor, Ameyaw, Luterbacher, Akrofi and Boakye, 1994)

The rate of adoption of chemical fertilizer was only 46.9 per cent. Liberal economic policies improved the availability of fertilizers although the prices increased when subsidies were removed. Although soils in many areas of the study supported the cocoa crop for long periods of time, most farmers made little or no effort to replenish their lost nutrients.

Judicious use of inorganic fertilizers could dramatically improve production. However, many farmers did not adopt the application of chemical fertilizers because relying solely on inorganic relatively expensive fertilizers has a number of associated problems. Firstly, they are expensive and many cocoa farmers cannot afford to buy them. Also, after long periods of cultivation, the soil can become acidic and unproductive. Mulching with organic material such as cocoa pod husks and the use of leguminous plants as cover crops, which also smother out weeds, are options for maintaining good fertile soils. Cocoa pod husks are an excellent source of nutrients, and composting them can provide a cheap source of organic fertilizer.

The rate of adoption of herbicides was very low (14.1 per cent) Probable reason for the low adoption rate could be farmers' perception that the use of herbicides is risky. The wrong use of herbicides could be disastrous Farmers are often reluctant to take risks, because risk-taking could put their plantations in jeopardy. Furthermore, some farmers would not change their more stable cutlass weeding, which is a lower-return technique for riskier, more profitable herbicide application. In order to sustain the adoption of chemicals, it would be necessary to intensify farmer education and to remove bottlenecks in the supply and distribution of chemical inputs.

Harvest and Post-Harvest Technologies

The harvest and post harvest technologies include regular harvest, fermentation of beans, stirring of beans during fermentation, and burial of pod debris after pod breaking. Figure 28 shows the rates of adoption of harvest and post harvest technologies. The rate of adoption of regular harvesting of pods was 73.4 per cent. Most farmers adopted the technology because the adoption of regular harvest relates to economic gains, such as better quality product and increased bean weight. Thus regular harvest has a relative advantage over delayed harvest. Probable reason why some farmers preferred longer periods between harvests was that they believed that a longer period allows pods to ripen better. However, delayed harvesting encourages fermentation of beans within the pods. This results in a low quality product. In addition, delay in harvesting encourages the incidence of black pod disease and rodent attack. Extension workers should explain the reasons for frequent and regular harvesting to farmers for them to appreciate the importance and need for early harvesting.

The rate of adoption of fermentation by farmers was 71.8 per cent. This shows that about one third of farmers did not ferment their beans before drying. Unfermented beans lead to poor quality product. According to Mossu (1992), the most important change that occurs during fermentation is the appearance of the precursors of the chocolate flavor. These substances, which among others, contain free amino acids and monosaccharides, are capable of giving the cocoa beans, after roasting, the characteristic flavor and aroma sought after in this product.

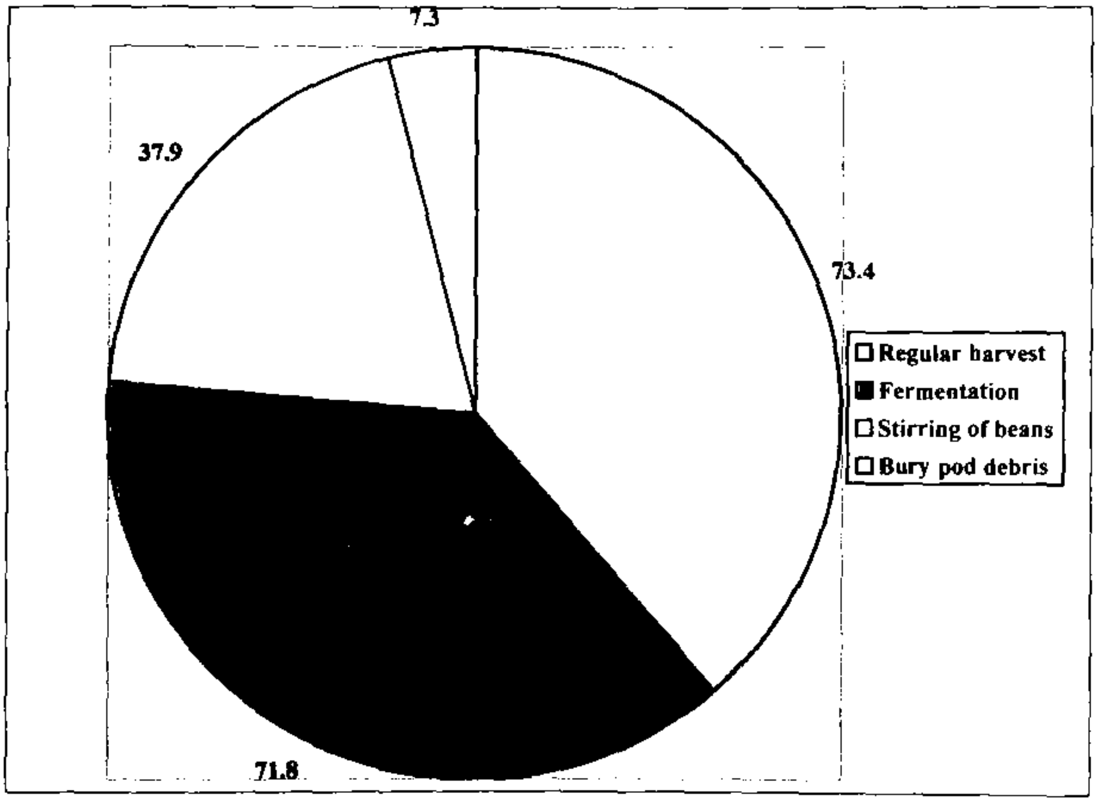


Figure 28 Rate of Adoption of Harvest and Post-Harvest Technologies

Source: Field Data, 2004

The rate of adoption of stirring of the entire mass of beans during fermentation was 38 per cent. Stirring of beans during fermentation is necessary to promote aeration and to obtain even fermentation. Majority of farmers did not adopt this technology because of ignorance. The rate of adoption of burying of pod debris after pod breaking was as low as seven percent. This practice limits the spread of fungal diseases such as black pod. Lack of knowledge on the part of majority of farmers accounted for the low rate of adoption

The results obtained for the rates of adoption of technologies imply that adoption of most of the technologies has progressed past innovator adopter stages into the realm where adopting farmers are much like the majority of farmers. On the other hand, adoption of soil test, swollen shoot control, and herbicide for instance, imply that adoption was largely confined to innovators and early adopters who in general, tend to control substantial resources and who were willing to take risks associated with trying new ideas. Rogers (1983) noted that rate of adoption is affected by both the individual's characteristics and the nature of the social system in which the individual is a member. Moreover, different behavior regarding adoption, (as portrayed by farmers in the study), is a function of different opportunities and constraints as of inherent characteristics or perceptions of farmers (Cramb, 2005)

Background Characteristics of Farmers

Extension services need to know the background and personal characteristics of farmers they serve so that they can design appropriate strategies to reach the farmers effectively. The section presents description of farmers with respect to age; gender, education, experience and house hold size.

Age

Table 23 shows the age distribution of farmers interviewed Most farmers were aged or ageing

Less than ten percent of farmers fell below forty years of age Moreover, more than 35 % of the farmers were above the retiring age of sixty years. The mean age of the farmers was 56 years. It is worthy to note that many farmers gave their estimated age rather than their actual age since the latter was not known. The results confirmed the observations by Asante-Mensah (1988) He noted that majority of cocoa farmers were middle aged or old. Dankwa (2001) noted that the average age of cocoa farmers in Ashanti Region was 56 years. Asante (2002) further noted that most cocoa farmers interviewed were within the 50 to 70 years group

The implication of the results is that the old dominate production and that more young people should be encouraged to go into cocoa production. According to Johnson (1992) young men especially those with growing families have the greatest desire to maximize their income. Therefore, they tend to be progressive and innovative. Young people need more agricultural knowledge, skill, as well as positive attitudes towards agriculture and rural life, if they are to increase farm productivity and incomes in the future

Old men, on the other hand, have more experience in life but they often lack drive, modern knowledge and physical strength. No wonder, Rangaswamy and Ramasamy, (1972) described them as conservative and non-adopters of technologies.

Table 23: Age Distribution of Farmers

Age class (years)	Frequency	Percentage	Cum Percentage
Below 40	17	9.4	9.4
41-50	52	28.9	38.3
51-60	47	26.1	64.4
61-70	45	25.0	89.4
71-80	14	7.8	98.9
Over 80	5	2.8	100.0
Total	180	100.0	

Source: Field Data, 2004 **N=180**

Extension programs should not only target the old farmers who form the majority, but also influence the younger generation, who may often be the most amenable to new ideas and concepts (Watts, 1989).

Sex

Sex determination among respondents as shown in Table 24 has males making up of nearly 68 percent of cocoa farmers studied. Females in the present study constituted nearly one-third of the sample. Asante-Mensah (1988) and Dankwa (2001) confirmed the male dominance in cocoa farming in Ghana

Table 24: Sex Distribution of Farmers

Sex	Frequency	Percentage	Cum. %
Male	123	68.3	68.3
Female	57	31.7	100.0
Total	180	100	

Source: Field Data, 2004 **N=180**

The present study showed that women played a key role in cocoa production. In 2004, the best cocoa farmer in Western (South) Region was a woman. The national best farmer award also went to a woman. Extension should therefore, recognize the importance of women to the cocoa industry and recognize them as a target group. This means sensitizing extension personnel to the contribution made by women to the cocoa industry and then directing extension efforts to include women. It is essential that research and extension address the technology and related needs of women producers.

Education

As shown in Table 25, the study revealed that most farmers attended junior or senior secondary school. In addition, the extension services organized courses for 22 % of farmers. Farmers with no formal education accounted for 43 %. They could neither read nor write any language. Asante (2002) stated that majority of cocoa farmers interviewed received no formal education.

Table 25: Level of Education of Cocoa Farmers

Level of education	Frequency	Percentage	Cum %
No formal education	77	43.0	43.0
Middle school/JSS	97	54.2	97.2
GCE/SSS	3	1.7	98.9
Post SSS/GCE	2	1.1	100.0
Total	180	100.0	

Source: Field Data, 2004 **N=180**

To increase cocoa production through the use of new technology will require an increasing education, training and levels of knowledge of cocoa farmers in general and the illiterate farmers in particular. The complex nature of information collection and interpretation associated with chemical applications for instance, suggests that more education would enhance the ability of the farmer to utilize these technologies. Flexibility of mind to make the best use of new methods and conditions is probably best encouraged by raising the general level of knowledge of farmers and their families.

Levels of education affect extension directly. Illiterate farmers require more simple information. Extension can make use of other channels like printed materials, workshops and lectures to serve literate farmers. Huffman

(1977) noted that education is particularly important when extension activities are less intense.

Experience

Farmers' experience took account of the number of years of engagement in cocoa farming. As shown in Table 26, most farmers were experienced. They had been engaged in cocoa farming for ten years or more. About 12 % of farmers had less than ten years of experience. The minimum number of years of engagement in cocoa production was two, while the maximum was sixty-one. The mean number of years of experience was twenty-three

The study by Asante (2002) found similar results. Farmers' working experience ranged from three to sixty five years. The mean was 23 years. Only five percent of the farmers had less than ten years working experience. According to Dankwa (2001), cocoa farmers in Ashanti Region had rich experience in cocoa farming, averaging 23 years. Majority of them had worked for 15 years

With the rich experience of most farmers it would appear that lack of skills and knowledge on the part of the farmers was not a constraint to increased production. It is generally accepted that wealth of knowledge is obtained through experience over the years of work. It is, therefore, expected that farmers' accumulated experience in cocoa production would positively influence their perception of improved technologies. Experience is probably a reliable forecast of farmers' future performance. Length of farming experience will positively affect adoption. The results of the study means that few people were just becoming established in the industry. This group of people merit special attention from extension workers, as their educational needs might be different from those of the established farmers.

Table 26: Distribution of Farmers by Experience in Cocoa Farming

Years	Frequency	%	Cum. %
Below 10	22	12.20	12.20
10 – 20	68	37.80	50.00
21 – 30	47	26.10	76.10
31 – 40	26	14.50	90.60
41 – 50	15	8.30	98.90
Over 50	2	1.10	100.00
Total	180	100.00	

Mean: 22.85 Standard Deviation: 12.48 N=180

Source: Field Data, 2004

Household Size

As shown in Table 27, the size of households of farmers varied in the number they contained. Most farmers had household size of up to five members. Nearly 24 percent of farmers had six to ten members living under the same roof. Eight farmers (less than 5 %) had more than 15 members in the household. Asante-Mensah (2001) also found that most farmers had medium-sized households with seven to fifteen members. Just over 20 % had small households. Respondents with large or very large families made up of 18 percent.

Cocoa production is labor intensive. The importance of household size in the study is that it serves as a rough measure of the pool of "free" labor potentially available to farmers. Although the absolute size of households is important, arguably the composition, namely the number of children, adult males and females, may be a far more relevant factor because of the differences between adults and children and between males and females in their contributions to farm labor.

Table 27: Household Size of Farmers

Number	Frequency	Percentage	Cum %
1-5	129	71.70	71.70
6-10	43	23.80	95.60
11-15	4	2.20	97.80
16 and above	4	2.20	100.00
Total	180	100.00	

Source: Field Data, 2004 **N=180**

According to Reijnties, Haverkort and Water-Bayer (1992), each household is a unique combination of men and women, adults and children, who provide management, knowledge, labor, capital and land for farming. Therefore, household size is important for the cocoa industry.

Level of Adoption of Cocoa Production Technologies

As shown in Figure 29, nearly 2.8 % of the technologies showed very high levels of adoption, 33.3% received high levels, and 31.7 % of the technologies had moderate levels of adoption. In addition, nearly 19 per cent of technologies had low levels of adoption, whilst 13.3 per cent had very low levels of adoption. Dankwa (2001) found a high level of adoption of technologies in the Ashanti Region. He attributed the high level of adoption to the long working experience of the cocoa farmers and contacts with front line extension staff. The Plausible reason for the lower adoption levels in the present study could arise from the inclusion of more technologies, such as soil test, burying of pod debris. The inclusion of the technologies was to introduce originality and innovativeness. We do not need "more of the same" in the study of adoption.

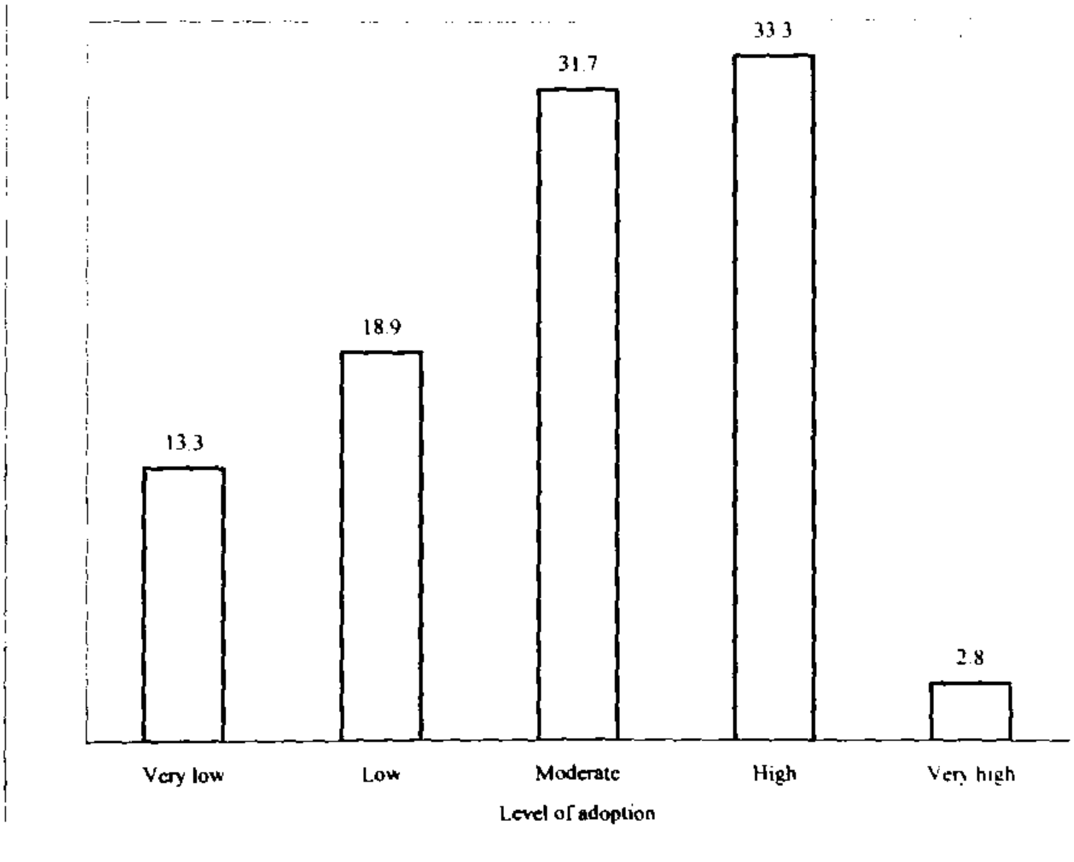
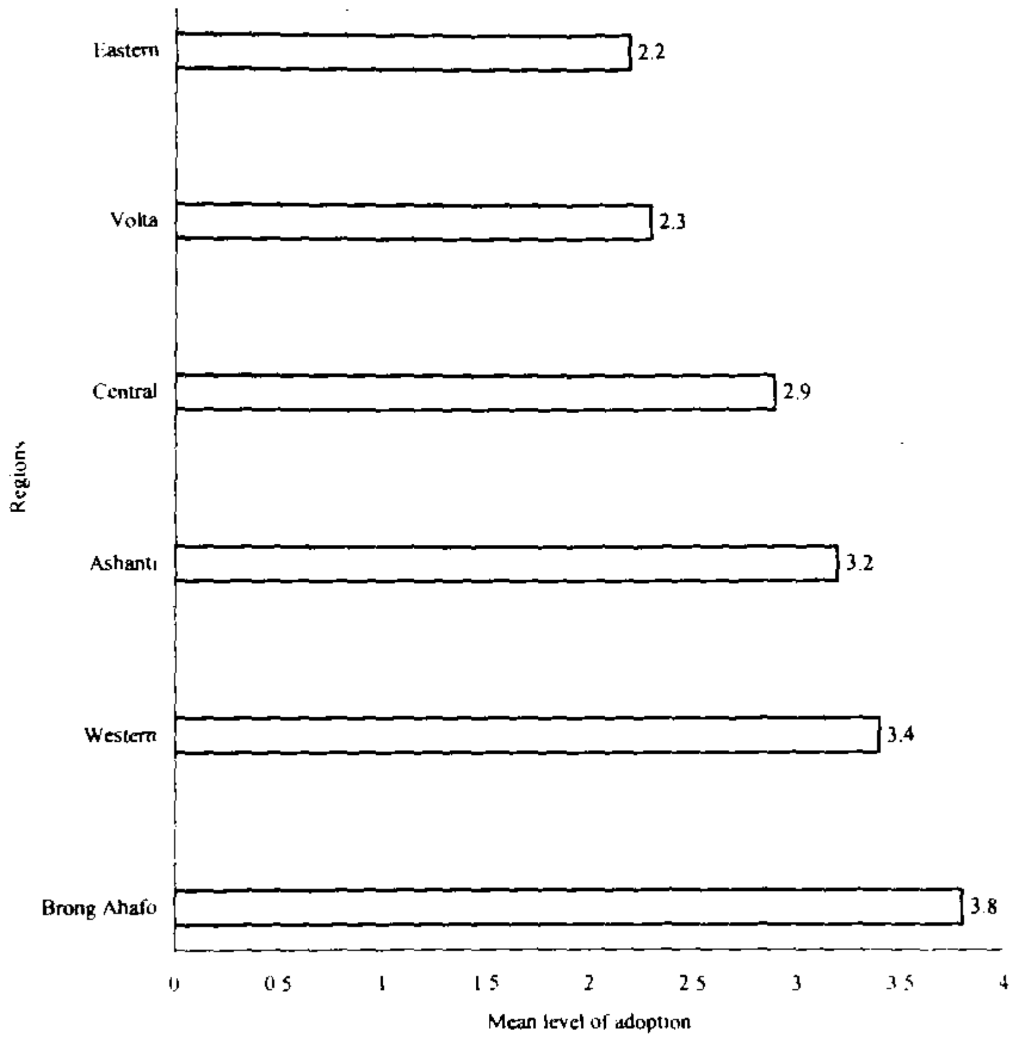


Figure 29 Mean Level of Adoption of Cocoa Technologies

Source: Field Data, 2004

In addition, the Brong Ahafo Region had a high level of adoption of technologies. The Central, Western and Ashanti Regions had moderate levels of adoption. However, the Volta and Eastern Regions had low levels of adoption of technologies.

ANOVA



F=13.911, Sig= 0.000 , Alpha level=0.05

5=Very High (above 20), 4=High(16-20), 3=Moderate(11-15)

2=Low (6-10), Very Low(0-5)

Figure 30 Level of Adoption of Technologies (Region by Region)

Comparisons of the Level of Adoption of Technologies Region by Region

As shown in Table 27, significant differences existed between some of the regions as regards the level of adoption. For instance, the Central and Brong Ahafo Regions differed significantly. The Western Region showed significant differences with both Eastern and Volta Regions. Differences between the Ashanti, Eastern and Volta Regions were also significant. The Brong Ahafo farmers adopted more technologies than farmers in the Central Region, Eastern and Volta Regions. The Western Region farmers adopted more technologies than farmers in the Eastern and Volta Regions.

Table 28: Multiple Comparisons of the Level of Adoption Region by Region

(I) Region	(J) Region	Mean Difference (I-J)	Std. Error	Sig.
Central	Western	-.4839	.2303	.494
	Brong Ahafo	-.8957*	.2322	.013
	Ashanti	-.3624	.2322	.786
	Eastern	.6924	.2364	.133
	Volta	.6117	.2387	.261
Western	Brong Ahafo	-.4118	.2322	.678
	Ashanti	.1215	.2322	.397
	Eastern	1.1763*	.2364	.000
	Volta	1.0956*	.2387	.001
Brong Ahafo	Ashanti	.5333	.2341	.397
	Eastern	1.5881*	.2383	.000
	Volta	1.5074*	.2405	.000
Ashanti	Eastern	1.0548*	.2383	.002
	Volta	.9741*	.2405	.007
Eastern	Volta	-8.0688E-02	.2446	1.000

The mean difference is significant at the 0.05 levels.
Source: Field Data, 2004

Moreover, farmers from Ashanti Region adopted more technologies than their counterparts in the Eastern and Volta Regions. To the extent that the farmers in the regions were not identical in their background characteristics and socioeconomic factors, the differences in the levels of adoption in the regions are not unexpected. The explanation of the different adoption behavior from region to region had to come from differences in established behavior patterns of members of each region. Change agents' efforts, communication channels used and the attributes of the technologies studied could affect the adoption pattern as noted by Rogers (1983). Extension should consolidate on the gains made in the regions with high adoption levels and strengthen efforts in those regions with low levels of adoption.

Relationships Between Background Characteristics of Farmers and the Level of Adoption of Cocoa Production Technologies

Table 28 represents the results of Pearson's correlation analysis between adoption level and age, educational level, experience and size of household of farmers. Age of farmers and level of adoption of technologies were negatively correlated. The implication is that older farmers adopted fewer technologies. Conversely, the younger farmers had higher level of adoption of technologies. Dankwa (2001), on the other hand, noted that the two variables (age and adoption level) had a positive relationship. Nevertheless, Asante-Mensah (1988) found that a farmer's age had no relationship between age and the overall adoption of cocoa technologies.

The negative direction of the present correlation may seem a bit unusual, but quite reasonable. The old, particularly, those over 60 years, might have more experience in life, more resources or authority that could allow them more possibilities for tying a new technology. However, they are often incapable in various ways, such as drive, modern knowledge and physical strength. Rangaswamy and Ramasamy (1972) described them as conservative and non-adopters. According to Johnson (1992), a farmer's age often influences his effectiveness, particularly, the post maturity or pre-retirement period when changed goals and other influences lower his effectiveness.

Table 29: Pearson Correlation Matrix of Framers' Background and the Level of Adoption of Technologies

Variables	Adoption	Age	Education	Experience	Household
Adoption	1.000				
Age	-.070	1.000			
Education	-.029	-.278**	1.000		
Experience	-.061	.638**	-.200*	1.000	
Household	.184*	-.242**	-.025	-.224**	1.000

*Correlation is significant at the 0.05 levels

**Correlation is significant at the 0.01 levels

Source: Field Data, 2004

Younger farmers, on the other hand, have greater likelihood of adoption of technologies. La Anyane (1985) reported that in many cases, health and age determine the work a farmer can do. Masdar Consultancy Report (1977) also reported that old age was one of the major constraints to increased production of cocoa. According to Watts (1989), the younger generation may often be the most amenable to new ideas and concepts. Furthermore, Akinola (1986) noted that younger farmers have greater likelihood of adopting new technologies due to their zeal to acquire and use farm information. He also observed an inverse relationship between age and the number of technologies adopted in Nigeria. Young farmers are likely to adopt improved technologies and use them (Feder and Slade, 1985). According to Johnson (1992), young men with growing families, have the greatest desire to maximize their income. They are progressive and innovative.

The correlation between education and level of adoption of cocoa technologies was negative. While Asante-Mensah (1988) found no significant relationship between the two variables, Dankwa (2001) found a significant relationship between the two variables under review. Hailu (1990) also found that education determined the adoption and use of new technologies, in his studies of level of improved farm practices in Ghana.

From the negative direction of the correlation, the implication is that the more the farmers were educated, the less they adopted technologies involved. Conversely, farmers with lower education had higher level of adoption of technologies studied. This is not consistent with correlation theory nor does it imply that a cause and effect relationship is being established here. The negative relationship could mean ineffective use of educational talents and that illiteracy did not prevent farmers from adopting new technologies. The adoption of many of the technologies studied may not depend so much on the educational level of the farmers. For instance, weeding, pruning, and harvesting etc. have less to do with educational level of the farmer. Moreover, most trained agriculturists in Ghana do not opt for actual production. Most trained agriculturists rather prefer to work in the Ministries or other service oriented organizations.

Farmers' experience in cocoa farming correlated negatively with the level of adoption of cocoa technologies. The work of Asante (2002), confirms the results in his studies of adoption of cocoa technologies. Dankwa (2001), however, found a positive relationship between experience and adoption of cocoa technologies.

In the present study, farmers with less experience in cocoa farming, had higher level of adoption of technologies, and vice versa. Could it be that farmers with less experience adopted more technologies as a result of advice on technologies they received? If this were so, then that was a positive influence of agricultural extension. Or could it also be that the agricultural extension agents deliberately chose to work with farmers who had relatively less experience? If this were also the case, then extension workers need to know their obligation to both the less experienced farmers as well as the more experienced farmers.

Shute (1980) found that extension contact with cocoa farmers was negatively associated with the number of years of cocoa growing. Such farmers may be so set in their traditional ways of doing things on the farm that they do not feel the need for advice from the young and educated extension officer. On the other hand, the extension officers are likely to pay more attention to the new entrants who may be younger and more educated than the established cultivators

Cocoa farmers with long years of experience are typically older. Farmer experience may not be associated with level of adoption because experience and age tend to be correlated. Older farmers are probably less likely to adopt technologies because of their shorter planning horizon. Asante-Mensah (1988) stated that the longer the time a farmer spends carrying out a certain practice, the more accustomed he becomes to doing it that way. A farmer's method and practices develop more into habits or set patterns of farming behavior. Such fixed farming behavior would then pose a barrier to change. Recommended practices would be more highly adopted by farmers who farm for a shorter time than those who farm for a longer time.

The results of the study showed a positive correlation between household size and adoption of cocoa technologies studied. The relationship was significant. The interpretation for this association is that farmers' household size directly influenced their adoption of cocoa technology adoption. The implication is that the fact that a farmer had larger household size was a factor to lead to an increase in adoption level. This inference is quite understandable because farmers with relatively more low-cost family labor could adopt more technologies. Hailu (1990) found a relationship between family labor and the level of adoption of new technologies in the Northern Ghana.

Farm Related Resources

The study dealt with the following farm related factors: farm size, labor, credit, machinery/equipment, land tenure, yield, marketing, and price of produce.

Farm Size

As shown in Table 30, most farmers had farms less than five hectares in size. The farm sizes of 20 percent of farmers were five or more hectares. The minimum size was 0.4 hectare, while the maximum was 20.2 hectares. Asante-Mensah (1988) noted that 52 % of farmers had farms of eight hectares in size with 15.6% said to have big farms of over 20 hectares in size. Furthermore, Dankwa (2001) observed that the mean size of respondents' cocoa farms was approximately six hectares, whilst the mode was four hectares. The maximum was 40.5 hectares. The majority of cocoa farms in West Africa are smallholdings owned by a large number of peasant farmers. For example, in Ghana, about 66% of farms are within the size range of 0-8 ha owned by 332,244 peasant farmers, with only 18.9% of the farms larger than 20 ha (Cocoa Services Division, unpublished data).

The present study shows that in the cocoa-growing belt, part of the land is in the hands of a few large owners. If the objective is to increase total production, then extension's focus needs to emphasize on these more progressive farmers where more rapid, short-term progress is possible. In addition, part of the land consists of small producing units that may be difficult to farm economically. We can recognize a host of small farmers representing the bulk of producers of cocoa for the nation. Therefore, they should be the appropriate target and concern of research and extension.

If the goal is to pursue broad-based cocoa development by increasing the income generating opportunities for the mass of small farmers, then they should have access to new technologies, inputs, credit, and other factors that are appropriate to their needs for increasing their productivity and incomes. Feder, Just, and Zilberman (1984) suggested that land holding size is a surrogate for a large number of potentially important factors such as credit, capacity to bear risk, access to inputs, and information as well as wealth. Only the few large holders could afford to satisfy the demands of the factors mentioned.

Table 30: Distribution of Farmers by Farm Size

Farm size (Ha)	Frequency	Percentage	Cumulative %
Less than 5	150	80.0	80.0
5-10	21	15.0	95.0
11-15	4	2.2	97.2
16-20	4	2.2	99.4
Over 20	1	0.6	100.0
Total	180	100.0	

Source: Field data 2004 **N=180**

Minimum=0.4 Maximum=20.2 Mean=3.7 Std. Deviation=3.58

and infra-structural facilities have also resulted in the drift of the youth from the rural areas to the urban areas. This has greatly affected the availability of farm labor, leading to high cost of labor and, consequently, the deterioration of farms.

Table 31: Availability of labor

	Frequency	Valid %	Cumulative %
Not available	5	2.8	2.8
Very difficult to come by	20	11.1	13.9
Difficult to come by	72	40.0	53.9
Easy to come by	52	28.9	82.8
Very easy to come by	31	17.2	100.0
Total	180	100.0	

Source: Field data, 2004 **N=180**

(1998) observed that caretakers manage farms poorly. This results in high losses due to pests and diseases.

The study found out that farmers hired labor for farming activities. Chidebulu (1991) noted that farmers used to rely on unpaid laborers. Nevertheless, due to decreasing family size and increasing schooling of children, farmers depend on hired labor. Farmers hired labor on permanent and casual bases, depending on time dimension and the kind of contract involved. While 55 % of farmers hired labor on daily basis, few (5 %) hired labor annually. In general, smallholder farmers cannot adequately sustain permanent labor. They face less absolute risk. Therefore, they do not have much urge to employ permanent labor. Big time farmers, on the other hand, can afford to hire permanent labor.

High cost of labor was a major constraint to cocoa production as perceived by majority of farmers. The amount paid for hired labor varied sharply between the study areas. The amount paid varied from fifteen thousand to twenty thousand cedis. The amount paid was a function of the potential resourcefulness of the laborer, his negotiating ability, and anticipated level of utilization of his services.

Some migrant labor from Togo and Benin was available, the supply tended to be seasonal (Ministry of Finance, 1998).

Labor

Most (54 %) farmers found labor difficult to come by. However, 46 percent of farmers did not have problems with labor availability (Table 31). According to MASDAR Consultancy Report (1997), availability of more rewarding opportunities for labor adversely affected cocoa production. Labor became a scarce input after the Aliens Compliance Order of 1969/70. Although The educated youth do not want to work as laborers on farms. More so, the living conditions in the rural areas do not encourage the retention of literate labor. According to Padi and Owusu (2003), the poor educational, health, communication

Table 32 shows the sources of labor available for cocoa farmers, namely, family, caretaker, hired, both daily and annual bases, share cropper and "nnoboa". The analysis shows that 31.1 % of farmers used family labor in their operations. Family labor used to be the traditional source of labor for the cocoa industry. However, Dankwa (2001) noted that family labor was scarce because of the out-migration of children and dependants. Moreover, family labor is scanty due to compulsory education and unattractiveness of cocoa farming to the youth. Caretakers accounted for 25 % of labor employed by farmers. Caretakers maintain farms for the aged and absentee farmers. However, Ministry of Finance Report

Non-wage costs such as meals increased labor cost for farmers. Even though a vast majority of farmers (94.4%) did not rely on sharecroppers for cocoa cultivation. Vigneri, Teal, and Maamah (2004) observed that cocoa land productivity was higher on land cultivated by a specific form of sharecropping contract: the traditional category of abusa farmers (who retain one third of the harvest) outperformed both owner-farmers and abunu sharecroppers (who retain one half of the harvest). They asked researchers and policy makers to note that cocoa yield is higher on sharecropped land and the right incentives such as sharing the cost of inputs and the risk of crop failure can help improve land productivity.

Most farmers noted that "nnoboa" system prevailed in their villages. Nearly 37 % 203farmers took part in the system. Activities undertaken in the system included land clearing, transplanting, and transporting of seedlings. Other activities were weeding, harvesting, and pod breaking.

Table 32: Sources of Labor

Source	Frequency	%
Family	56	31.1
Caretaker	45	25.0
Hired daily	99	55.0
Hired annually	9	5.0
Shared cropper	10	5.6
Nnoboa	107	59.4

Source: Field data, 2004 **N=180**

Credit

As shown in Table 33, majority (51.4%) of farmers in the study received credit for farm operations. About 11 % of farmers received credit directly from private moneylenders, while 16.4 per cent of farmers obtained credit from friends and relatives. Financial institutions gave credit to nearly eight per cent of farmers. The local purchasing companies also guaranteed credits to 15 per cent of farmers. In addition, one per cent of the farmers received credit in the form of hybrid seedlings from Cocoa Board. Credit was therefore, an important factor in determining adoption of technologies.

External off-farm income sources included remittances from relatives and pension entitlements. These sources are of relevance since they enable the farmer to undertake cocoa production activities, which may otherwise jeopardize his/her subsistence income.

Table 33: Farmers' Sources of Credit Acquisition

Source	Frequency	Percent	Cum %
Friends and Relatives	29	16.4	16.4
LBCs	27	15.0	31.4
Money Lenders	20	11.0	42.4
Banks	14	8.0	50.4
COCOBOD	2	1.0	51.4
None	88	49.0	100.0
Total	180	100.0	

Source: Field Data, 2004 **N=180**

As shown in Table 34, majority of farmers mentioned high interest rate as the major problem of credit acquisition. Other problems mentioned were cumbersome processing procedures and lack of collateral, as noted by Okali, (1983)

Table 34: Problems of Credit Acquisition

Problem	Frequency	Percentage	Cum. %
High interest rate	112	62.2	62.2
Cumbersome processing procedure	58	32.2	94.4
No collateral	10	5.6	100.0
Total	180	100.0	

Source: Field data, 2004 **N=180**

Farmers' savings habit indicated that 64.4 % of farmers operated bank accounts. While majority (67.0 %) of farmers operated savings account, the rest operated credit union, current, and Akuafo cheque accounts. However, only 41.7 % of farmers saved money from proceeds from their cocoa farms.

Table 35: Farmers' Perception of Credit Acquisition

Perception	Frequency	Percentage	Cum. %
Very easy	3	1.7	1.7
Easy	26	14.4	16.1
Difficult	62	34.4	50.6
Very difficult	65	36.1	86.7
Cannot say	24	13.3	100.0
Total	180	100.0	

Source: Field data, 2004 **N=180**

As shown in Table 35, most (70.5 %) farmers perceived credit acquisition to be difficult or very difficult. Only 16.1 % perceived credit acquisition to be easy. Lack of credit could be a serious disincentive for any extension program.

Machinery and Equipment

Most farmers owned harvesters and earth chisels. The comparatively large number of farmers who owned harvesters and earth chisels could be due to low cost involved in purchasing them. Only 10.7 % of farmers owned standard pruners. This finding confirms Asante-Mensah's (1988) observation that the majority (87.4%) of non-adopters of the recommended practice of mistletoe control lacked pruners. In addition, minority of farmers owned both hand sprayers and mist blower spraying machines. More farmers acquired hand sprayers than mist blowers because the former is cheaper.

The study emphasized the fact that many farmers could not adopt high cost foreign machinery and equipment. Research should focus on low cost and locally available inputs. The study further revealed that farmers could borrow or rent machinery and equipment when the need arose. Farmers borrowed from friends, relatives, and farmers' societies. The success of the cocoa industry greatly depends on the availability of equipment and machinery. Therefore, the ability of companies and organizations to provide a wide range of machinery and equipment, and just as important, spare parts, could influence the adoption of technologies.

Land Tenure

A major concern for the development of the cocoa industry is farmers' access to land, the primary source of production. As Table 36 shows, about one-third of respondents farmed on family lands. By virtue of inheritance, 22.8 % of farmers owned farmlands. In addition, 16.7 % of farmers acquired land as gifts. Sharecropping accounted for 15.0 % of farmland ownership. About 12 percent of farmers acquired lands through citizens right to community lands, leasehold, rental, and outright purchase. Dankwa (2001) has observed that majority of farmers established farms on family land. Nearly 13 % of farmers purchased land for cocoa. About 18 % of farmers were sharecroppers.

An important element of the land tenure issue is the fact that farmers with family, gifted, and inherited lands had security of tenure. Long-term security is crucial to agricultural growth. Hence, farmers with secured lands have greater advantage to adopt technologies. However, they are limited in their ability to expand. Farms inherited often do not receive proper maintenance. Owners sometimes abandon such farms. This situation leads to the spread of diseases and pests to healthy farms.

The sharecropping arrangement consisted of 'abunu' and 'abusa' systems. The abusa system may make adoption of technologies more attractive to sharecroppers, unlike the abunu system. Rented and leasehold lands are more attractive to farmers, who cannot afford outright purchase of farmlands. It is obvious that farmers will husband land they own better than land they rent. Moreover, renters, unlike purchasers, may be less interested in technologies that have long-term improvements such as soil conservation. But if they are long term tenants, (often for several generations) and are totally dependent on the land for their daily livelihood, they are likely to take good care of it and adopt far reaching technologies.

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Table 36: Mode of Land Acquisition

Mode of acquisition	Frequency	Percentage	Cumulative %
Family	59	32.8	32.8
Inheritance	41	22.8	55.6
Gift	30	16.7	72.3
Sharecropping	27	15.0	87.3
Citizens right	9	5.0	92.3
Leasehold	6	3.3	95.6
Rental	4	2.2	97.8
Purchase	4	2.2	100.00
Total	180	100.0	

Source: Field data, 2004 **N=180**

Yield of Farmers

Table 37 shows the yield of farmers during the past three years. The minimum yield recorded by farmers for 2001/2002-crop season was 2.2 kilograms per hectare, while the maximum yield was 2,956.8 kg/ha. The following year saw the minimum yield reduced to 0.8 kg/ha. However, the maximum increased to 3,498.4 kg/ha. In the 2003/2004 year, the minimum yield was 1.1 kg/ha, whereas the maximum yield was 3,277.0 kg/ha. (nearly twice the yield of the previous year). The mean yield for the 2001/2002 was 270.2 kg per hectare. Farmers recorded 14.2 % mean yield increase during the following year. Mean yield further increased to 18.2 percent in 2003/2004

Table 37: Mean Yield in Kilograms Per Hectare

Season	Frequency	Minimum	Maximum	Mean	Std. Dev	% Change
2001/2002	149	2.2	2956.8	270.2	169.9	-
2002/2003	157	0.8	3499.9	314.7	258.6	14.2
2003/2004	150	1.1	6790.5	384.7	243.9	18.2

Source: Field data, 2004 **N=180**

The gradual increases in production over the years, according to farmers, were due to: Adoption of pests and diseases control measures, application of fertilizers, and favorable weather conditions. The annual gains in production should not be signals for complacence. Farmers need support to consolidate and build upon the gains to ensure persistent and sustainable increases in production. The adoption of technologies is one sure way of increasing production. Extension will have to work more closely with researchers and farmers for technologies to make an appreciable impact on production.

Marketing of Produce

The section deals with storage and transportation of produce to buying centers. Others aspects covered include local buying companies, pricing, and mode of payment. The rest are smuggling, payment of bonus, and sale of 'Abinkyi' cocoa. Majority (96%) of farmers stored their produce in jute sacks provided by the LBCs. The rest stored their produce in baskets and plastic bags.

Majority (81%) of farmers carried cocoa by head loads for sale. Farmers who used vehicles to convey their produce to the LBCs formed 19%

of respondents. Such farmers were large-scale producers. Majority of farmers (92.9%) mentioned that the Produce Buying Company (PBC) operated in their villages. Olam, Adwumapa, Transroyal, and Cocoa Merchants operated as well in the study area. The presence of PBC in majority of villages is not surprising, since it is the oldest company established. The rest came into existence with the reintroduction of multiple buying companies.

In addition, majority (71.4%) of farmers sold their produce to the PBC. The rest (28.6%), sold to the other companies. Farmers' choice of LBCs depended on prompt payment, availability of credit, and accountability or trust of companies involved. The local purchasing clerks graded the produce of 54.4 % of farmers before taking delivery. On the other hand, 45.4 % of farmers sold their produce without grading by the LBCs. To maintain good quality produce it is essential that purchasing clerks grade all produce. An effective means of improving quality is to provide incentives to producers through transparent price differentials. This could be achieved through an objective grading system. A challenge would be to keep the grading system free from corruption. A corrupt environment would damage the free market mechanisms that create a competitive environment among cocoa traders. Higher quality crops could also be achieved through extension programs to educate farmers about more productive farming and processing techniques.

Whereas most farmers (70.7%) received cash for payment, 21% received 'Akuafo' cheque. Few farmers (8.3%) received both cash and cheque for payment. Farmers prefer the Akuafo cheque system to cash payment for reasons of security and confidentiality. However, delays at banks when cashing cheques create inconvenience in the cheque system. On the other hand, payment by cash is fast and convenient to the farmer. Purchasing clerks sometimes abscond with huge sums of money. Moreover, it is risky for the LBCs to carry huge sums of money to cocoa growing areas for payment of cocoa purchased. Banks should ensure faster payment for farmers' produce.

The study sought farmers' responses on smuggling of cocoa across the boarders. Minority of farmers (6.5%) stated that smuggling took place across the boarders. However, only one district shared boarders with a neighboring country (Hohoe and Togo). Many farmers felt reluctant or hesitant to talk about smuggling.

Although majority of farmers (65.6%) received bonus, more than a one third (34.6%) did not receive any bonus. A review of the payment of bonus could ensure fairness to all farmers. Many farmers felt cheated in the payment of bonus. Proper records on sale of produce could ensure fairness in the payment of bonus.

Only 12.8% of farmers sold "Abinkyi" cocoa. This may imply that majority of farmers maintained good quality beans. However, there is room for improvement in farm hygiene and proper fermentation to reduce the quantity of "Abinkyi" sold.

The heart of pricing in competitive markets is the balancing of supply and demand. However, for cocoa produced in Ghana, demand and supply do not determine the price of produce. The government rather fixes the price for the producer. Administered prices lead to inefficiencies because they do not transmit market signals correctly. This leads to distortions in resource allocation and an environment in which farmers cannot respond to fluctuations in world supply and demand (i.e. isolation from the market). A free market can create a competitive value chain with low intermediary margins, thus rewarding the farmer according to price fluctuations on a worldwide level

Most farmers (94.1%) did not know how the government fixes the price of cocoa. To appreciate the price paid for their produce, farmers should first learn about what goes into the price determination. For extension personnel, knowledge of pricing policies represents an important source of knowledge needed by farmers (Watts, 1989)

It is expected that earnings from cocoa will pay for all operations on the farm and leave enough surplus either for expansion or investment in technology adoption. Regrettably, however, cocoa prices in Ghana have not enabled the realization of this expectation. Most farmers considered the price of cocoa as low. The profit margin of about seven hundred and fifteen thousand cedis per hectare, the equivalent of three hundred and ten US dollars ($310), for the Ghanaian cocoa farmer as noted by Asante (1997) is grossly inadequate. The margin is even less under the sharecropping system.

It necessary to increase cocoa price to a level comparable to, if not more than those of other crops. A high producer price will be an incentive for farmers to improve their farms, if they know they will obtain fair returns on their investment (Anon, 1995). Moreover, a remunerative producer price is necessary for attracting the youth into cocoa farming and to sustain farmers' interest.

Farmers' opinions on ways to improve the internal marketing of cocoa revealed that majority wanted a reduction of the number of local buying companies. This, according to them, will ensure good quality beans and prevent stealing of produce. Farmers called for proper records keeping by the produce-buying clerks. In addition, most farmers called for prompt payment for produce by buying companies. Improving the road network will ensure efficient transportation of produce to buying centers. Frequent checks of weighing scales increases pricing efficiency. It also improves transparency in pricing and ensures uniformity and convenience in transactions.

Relationships between Farm-Related Factors and Level of the Adoption of Cocoa Production Technologies

The section discusses the hypotheses developed with respect to the relationships between levels of adoption of technologies as dependent variable and the following farm-related independent variables: Farm size, availability of labor, availability of credit, total machinery and equipment owned by farmers and output. The correlation matrix of the farm related variables and level of adoption of technologies appear in Table 38.

A positive relationship was found between farm size and level of adoption of technologies. The implication is that cocoa farmers with larger farms tend to adopt more technologies. The possible reason could be due to the fact that farmers with larger farms could earn more money to be able to adopt technologies. On the other hand, cocoa farmers with smaller farms are likely to adopt fewer technologies because they have lesser amount of money to be able to adopt technologies.

Table 38: Correlation Matrix of Farm Related Variables and Adoption

Variables	Adoption	Farm size	Labor availability	Credit availability	Equipment	Yield
Adoption	1.000					
Farm size	.098	1.000				
Labor Availability	.060	-.069	1.000			
Credit Availability	.169*	.100	.060	1.000		
Equipment	-.181	.060	.049	-.103	1.000	
Yield	.195*	.403*	-.087	.139	.241*	1.000

*Correlation is significant at the 0.05 levels

** Correlation is significant at the 0.01 levels.

Source: Field data, 2004

However, Asante-Mensah (1988) observed that farm size did not appear to influence the overall adoption of recommended practices. Farm size was not associated with the adoption of high-cost innovations (control of capsids). However, significant association existed between farm size and the adoption of low cost innovation (use of recommended varieties).

The studies by Binswanger, (1978), Weil, (1970), Clawson, (1978), and Rogers (1983) are consistent with and validate the present finding that the level of adoption on larger farms exceeds that of smaller farms. Other empirical studies show that inadequate farm size also impedes an efficient utilization and adoption of technologies (Dobbs and Foster, 1972; Lipton, 1978; Singh, 1979; Wiltshire, 1975; and Barker, 1981).

As shown in Table 38, labor availability shows positive correlation with level of adoption. The implication is that higher labor availability leads to greater adoption of technologies. The reverse is also true, that is, lower availability of labor leads to less adoption of technologies. The result implies that cocoa technologies being studied are labor intensive. However, the value obtained (.06), means that the strength of the relationship is not appreciable.

Helleiner (1975) noted that the operative constraint in African farming systems is peak labor scarcity. Labor supply problems may sometimes inhibit adoption of innovations, if they are labor intensive. However, labor-replacing innovations are adopted quite rapidly in areas, where labor availability depends on seasonal and uncertain supply. Hicks and Johnson (1974) found that higher rural labor supply leads to greater adoption of labor-intensive rice varieties in Taiwan. New technologies may increase the seasonal demand of labor so that adoption is less attractive for farmers with limited family labor or those operating in areas with less access to labor markets.

Asante-Mensah (1988), on the other hand, noted that no significant relationship existed between availability of labor and level of adoption of recommended practices. Low profits, high cost of labor, and other factors might be contributory factors to this situation. In the past, the traditional cooperative labor system, 'nnoboa' was an effective and indigenous arrangement for harnessing the available local labor. Farmers should rely more on 'nnoboa' system to ensure adequate labor force for farm operations.

Uncertainty regarding the availability of labor in peak season calls for the adoption of new labor saving technology. Farm mechanization could alleviate labor bottlenecks in cocoa production. For example, tractor power can reduce labor demand; make possible timely farming operations, especially weeding and transportation of produce

The correlation between credit availability and level of adoption of technologies was positive and significant. However, credit supply is not necessarily an obstacle to adoption, as evidence on this matter is mixed. While Wills, (1972) agreed that lack of credit is a crucial factor inhibiting adoption of innovations, Von Pischke (1978) and others, held a contrasting view on credit availability and adoption of technology. The study by Scobie and Franklin (1977) concludes that access to credit may not encourage adoption if it entails restriction on input use (e.g., lower limit on fertilizer and pesticide applications). In fact, evidence suggests that rational farmers will evade the restrictions.

Asante-Mensah observed no significant association between the use of credit for farm work and the level of adoption of recommended technologies. He believed that farmers used credit for only a few of the practices that immediately led to production, such as weeding and harvesting. Farmers perhaps, neglected other cumbersome practices such as pests and diseases control. Furthermore loans that farmers obtained were often either inadequate or untimely. Thus farmers did not adopt the appropriate technologies at the appropriate times

One policy advanced for minimizing the adoption-discouraging effects of credit scarcity is a subsidization of credit. But Lipton (1976) argues that subsidization of credit does not circumvent the problem for smaller farms since, in many cases, the larger and more farms manage to get the bulk of such credit

There appeared a negative relationship between total machinery and equipment owned by farmers and level of adoption of technologies. The implication is that farmers owning more machinery and equipment, adopted fewer technologies. The possible reason could be due to lack of fuel, labor, or other inputs such as spare parts. Therefore, ownership of machinery and equipment by farmers does not mean that farmers will adopt technologies. Some farmers regard some farm machinery and equipment as status symbol. For instance, it is not uncommon to find farmers who have one or two machines but would buy another, particularly, with the introduction of a new model or brand (Asante-Mensah, 1988). On the other hand, farmers may not own a particular equipment or machinery but still, they may adopt technologies. The study found that farmers could borrow or rent machinery and equipment within their communities.

A significant and positive relationship existed between yield and level of adoption of technologies. The implication is that farmers with higher yields tend to adopt higher levels of technologies, and vice versa. Asante-Mensah (1988) found a similar relationship between cocoa output and the overall adoption of recommended practices. Higher yield leads to higher income and farmers with higher income might be willing and able to adopt more technologies. However, it does not imply that higher income may not lead to acquisition of laborsaving and other types of machinery.

Test of Hypotheses

From the result of the study, the hypotheses that the sizes of household, credit availability and yield of farmers have no relationship with the levels of adoption of technologies cannot be accepted. However, the hypotheses that the relationship between the rest of the background characteristics of farmers and farm-related factors and the levels of adoption of technologies are, however, accepted

Constraints to Adoption of Cocoa Production Technologies

As shown in Table 39, farmers' inability to adopt technologies can stem from a variety of causes, but the most frequently mentioned constraint to adoption of technologies was the lack of credit facilities. About 44 per cent of farmers were unable to capitalize on the benefits of improved technologies due to credit constraints. Observations of many researchers validate this finding. For instance, Quadoo (1957), La Anyane, (1972), and Okali (1983), all support the farmers' assertion that lack of credit is blamable for non-adoption of technologies.

High price of inputs was the next constraint identified by farmers as limiting adoption of technologies. Asante-Mensah (1988) also mentioned that with the exception of fungicides, majority of farmers found all inputs expensive. Nearly 12 per cent of farmers mentioned labor shortage as a constraint to adoption of technologies. About eight per cent of farmers mentioned lack of knowledge of technologies. This resulted from weak extension delivery. Other constraints included illiteracy, old age all of which are consistent with the observations by Feder, Just, and Zilberman (1984) and Ghana Cocoa Board Special Report (1994)

Table 39: Constraints to Adoption of Cocoa Production Technologies

Type of constraint	Frequency	%	Cum %
Lack of credit	80	44.4	44.4
High inputs cost	44	24.4	68.8
Labor shortage	21	11.67	80.47
Weak extension	15	8.33	88.80
Illiteracy	12	6.67	95.47
Old age	8	4.44	100.00
Total	180	100.00	

Source: Field data, 2004 **N=180**

Variables that Best Predict Adoption of Cocoa Production Technologies

The best predictors of cocoa technology adoption came out of a stepwise regression analysis using the Statistical Product and Service Solutions (SPSS) From the results obtained in the Pearson's correlation matrixes, variables that showed significant correlations with the dependent variable (adoption of technologies) were size of household, credit availability, and yield. These constituted the variables, which entered the regression analysis. The size of household and credit availability emerged as the best predictors of the independent variables under study, after the regression analysis.

The size of household variable explains the greatest amount of variance in the dependent variable (Table 40). Adjusted R Square for size of household was .077 or 7.7 %. Therefore, size of household accounted for 7.7

% of the variance in level of adoption of cocoa technologies. The result implies that the greater the number of household a farmer had, the higher the level of cocoa production technologies the farmer adopted. According to Reijnties, Haverkort, and Water-Bayer (1992), each household is a unique combination of men, women, adults and children. They provide management, knowledge, labor, capital, and land for farming. The farm household is therefore, the center of resource allocation and adoption of technologies.

Cocoa farming is more labor intensive. It means it requires more labor input. Many farmers admitted they lacked the financial resources needed to employ more labor. Therefore, adoption will be less attractive for farmers with limited household labor. The result suggests that researchers should develop laborsaving technologies. This could help some household members to take advantage of wage-labor opportunities.

Credit availability was the next predictor of adoption of technologies. The R Square for credit availability is .046. This shows that the proportion of variance in the dependent variable that credit availability explains is 4.6 percent. One of the fundamental correlations of a science-based agriculture is that it involves an increase in the capital intensity of production. Chemical fertilizers, insecticides, fungicides, weed killers, spraying machines, are some products that farmers may purchase from off-farm sources. That means not only an array of linkages with input suppliers, but also a much more prominent role for linkages with financial institutions, particularly as sources of credit.

According to Owusu-Acheampong (1986), the most critical factor in Ghanaian rural farming situation is credit. It is obvious that attention to farmer credit is critical to the extension function, even though the extension service is not responsible for it as an organizational activity

Table 40: Regression of Predictor Variables of Level of Adoption of Technologies

Factor	Step of entry	Beta	R Square	Adjusted R Square	F Change	Sig
Constant	-	2.077				
Credit	1	.255	.054	.046	6.591	.012
Size of household	2	.200	.093	.077	6.133	.027

Source: Field data, 2004

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

The Chapter includes a summary, which deals with the objectives of the study, aspects of methodology and the main findings. On the basis of the analysis of the results of the study, conclusions reached appear after the summary. The chapter also highlights recommendations considered worthwhile to ensure increases in cocoa production in Ghana through technology dissemination and adoption of technologies. The chapter ends with suggested areas for further research.

Summary

The general purpose of the study was to examine the dissemination and adoption of cocoa production technologies in Ghana. The specific objectives were to identify current production technologies available for adoption by farmers, examine the communication factors associated with the dissemination of cocoa production technologies and to determine the rate and level of adoption of recommended technologies. Other specific objectives included identification of constraints that limit the adoption of technologies by farmers, description of personal and background characteristics of cocoa farmers and exploration of farm related factors involved cocoa production. The rest of the specific objectives were to show how the background characteristics of farmers and the farm related factors relate to the level of adoption of technologies. The identification of the best predictor variables of cocoa production adoption was the last specific objective.

Descriptive-correlational survey design was used to generate data for the study. Cocoa farmers countrywide constituted the population for the study. Relying on the multi-stage random sampling technique, 180 farmers were selected for the study. The research instrumentation involved the use of pre-tested structured interview schedule. Two trained enumerators administered the instrument. Descriptive statistics were used to analyze some of the data collected. Pearson-Product-Moment Coefficient of Correlation technique was used to determine the nature and strength of the relationships between level of adoption of technologies and background characteristics of farmers and farm related factors studied. Stepwise Regression was used to identify the best predictor variables of adoption of cocoa production technologies under study.

The results indicated that farmers employed both traditional and modern technologies in cocoa production. These technologies involved pre-planting, nursery and planting techniques. Other technologies included farm maintenance and chemical applications. The rest were harvest and post-harvest technologies.

Farmers considered soil types, vegetation, weather conditions and land availability in choosing particular sites for cocoa farms. Land preparation involved complete clearing of the undergrowth, followed by burning of the trash and felling of large trees. Food crops served as temporary shade, while permanent shading involved retention of 11- 15 trees per hectare. Both random and row spacing constituted the planting arrangement. Planting took place mainly in the first rainy season between the months of May-July. Farmers either planted at stake or planted nursery raised seedlings. Most farmers obtained planting materials from the Seed Production Unit of Ghana Cocoa Board. Others established their own seedlings or obtained pods from nearby farmers' farms. Post-harvest operations involved fermentation and drying of beans.

Most farmers were aware that cocoa extension was under the unified extension system operated by Ministry of Agriculture. Majority of farmers mentioned that contacts with extension workers were not regular. Farmers attributed this to the unification of the extension services. Farmers received extension services from many sources. However, members of staff of COCOBOD remained the principal sources of extension to cocoa farmers. Majority of farmers preferred that COCOBOD take to cocoa extension. Majority of farmers also preferred Production Technology Approach to extension, followed by Training and Visit Approach.

In dealing with extension workers, farmers sought information mostly on diseases and pest control. This is not surprising in view of the devastating effect of diseases and pests on cocoa, if not controlled. Other information sought by farmers included lining and pegging, planting materials and supply of inputs. Only few farmers enquired about post-harvest handling of cocoa. It is not surprising that there was a hue and cry about purple beans last year, a situation, which arises from poor fermentation, leading to poor quality of beans. Channels mostly used by extension workers in their interaction with farmers were group discussions and individual contacts. Majority of farmers preferred group methods to the other methods like lectures, symposiums and television

Few farmers adopted various technologies for the first time between 1933 and 1980. Majority of farmers adopted technologies that were mostly simple and low cost in application. These included regular weeding, shade establishment and fermentation. Technologies with low adoption rates were stirring of beans during fermentation, soil testing and burying of pod debris after pod breaking.

The overall level of adoption of technologies was moderate. Brong Ahafo Region had the highest level of adoption of technologies. Central, Western and Ashanti Regions had moderate levels of adoption, while Volta and Eastern Regions had low levels of adoption. Significant differences existed between various regions in levels of adoption of technologies.

Background characteristics of farmers revealed that majority of farmers were aged or ageing. Males made up the majority of farmers in the study. Farmers' experience in cocoa farming ranged from two to sixty-one years. The mean years of experience was twenty-three. Majority of farmers could read and write. About 69% of farmers' had household size up to five members. Household size of farmers showed significant correlation with level of adoption of technologies. On the other hand, age, educational level and experience showed negative correlation with level of adoption of technologies.

The farm size of majority of farmers ranged from one to five hectares. Among the farmers interviewed, majority found labor unavailable or difficult to come by. Majority of farmers did not save from sales of their produce. Although majority of farmers did not possess the equipment and machinery needed in cocoa production, they could borrow the items from the communities. While one-third of farmers owed family land, 22.5 % inherited land on which they produced cocoa. In addition, 17.3 % received land as gifts from benefactors. About 16 % of farmers were sharecroppers, while nearly nine percent of farmers owned lands through leasehold, rental or outright purchase.

In the 2001/2002 cocoa crop season, the mean yield obtained from farmers' farms was 270.2 kg per hectare. The mean yield for 2003/4 was 384.7 kg per hectare. Farmers attributed the increasing yields to favorable weather conditions, adequate diseases and pests' control and fertilizer application.

Various marketing companies operated in the study areas. However, the Produce Buying Company remained the most popular. While 57 % of farmers had their produce graded by the purchasing clerks, 43 % of farmers sold cocoa, which was not graded by buying agents. In the payment for their produce, 70 % of farmers received cash. The rest obtained both cash and cheque. About six percent of farmers reported that smuggling of cocoa took place in their communities. Majority of farmers received bonus, while 35 % did not benefit from this incentive package from the government. Only 12 % of farmers sold 'Abinkyi', the sub standard beans. It is interesting to note that 94 % of farmers did not know how the government fixed the price of cocoa.

The study revealed that only credit availability and yield correlated with level of adoption of technologies. Both relationships were positive and significant. The rest of the variables studied showed negative correlation with level of adoption of technologies. Constraints to adoption of technologies of technologies included lack of credit, high cost of inputs, weak extension, illiteracy and old age. However, the best predictor variables of adoption were household size and credit availability.

Conclusions

Based on the results and discussion, the following are the conclusions drawn -

1. Cocoa farmers had an array of technologies to choose from, in addition to their own wealth of experience in cocoa production. Farmers combined both traditional and science-based technologies in the establishment and maintenance of cocoa farms.
2. Majority of farmers were aware of the fact that cocoa extension was under the unified extension system of the MOFA. However, the unified extension system, as perceived by cocoa farmers, functioned at a level of intensity lower than what prevailed under the Cocoa Services Division. There is therefore, more room for improvement, as far as current cocoa extension is concerned.
3. Farmers preferred Production Technology Approach to extension. Farmers' confidence in the erstwhile Cocoa Services Division was remarkable probably, because they adopted the production technology approach to extension.
4. Farmers benefited from various extension channels during their interaction with extension workers. However, most farmers' preferred group meetings. Extension's focus on this method could ensure greater farmer participation. However, group meeting could not reach

every farmer in need for information. It is costly in terms of time spent and number of client contacts

5. The technologies should of necessity be effectively disseminated to the clientele. The uses of the most appropriate combination of communication channels are paramount, taking into account the socio-cultural and economic situations of the farmers. This will ensure that information is both available and accessible to all interested farmers.

6. Farmers sought information on production-oriented technologies mostly. Only few farmers sought information about post-harvest handling of the produce. If one considers the importance of quality of produce, any lack of knowledge by farmers on post-harvest handling of the produce has serious repercussion on the premium grade of Ghana's cocoa on the world market.

7. Farmers received extension services from many sources. However members of staff of Cocoa Board remained the most important sources of information to cocoa farmers

8. The adoption of technologies is not fortuitous and unpredictable. The character of the technology is itself an important determinant of adoption. Many technologies did not require any unique skills to implement. Although most of the identified technologies had clear advantages, technologies with the greatest payback potential tended to require external input and expensive capital outlay, which limited their full adoption by farmers. Examples are spraying machines and fertilizers. Thus, while the technologies were acceptable, some were not economically feasible for most of the sampled farmers.

9. Technologies which farmers perceived as simple, low cost and locally available received higher rate of adoption i.e. weeding, shade manipulation. However, technologies with perceived complex attributes had lower rate of adoption i.e. soil test and row spacing.

10. Apart from the high rate of adoption of insecticide control method, none of the other identified chemical applications had a high rate of adoption, and by implication, they made little impact in cocoa production. For production technologies to have full adoption, they should not only address the needs and problems of farmers, they should also be technically and economically feasible for adoption.

11. The adoption level of cocoa technologies was moderate, i.e. between 11 and 15 of the 25 technologies were adopted in the country as a whole. Farmers' adoption behavior differed across districts and over the years. The conclusion is that policies and programs aimed at increasing adoption need not be the same for all districts. Even if some common policies and programs need to be taken for all the districts, one should not expect to get similar responses since the effect of the policies and programs will be different. This is important because any policy or program should go with cost-benefit analysis.

12. Background characteristics and farm-related factors studied influenced the adoption of technologies. Other than the socio-economic and farm-related situations, government policies and programs greatly influenced the adoption behavior of farmers. For instance, the Cocoa Rehabilitation Program, Cocoa Hi-tech program and the Cocoa

Diseases and Pests Control Program witnessed higher adoption of technologies during their implementation

13. The high literacy rate of farmers was encouraging in view of the fact that education lies at the heart of technological transfer. Education makes farmers more receptive to advice from extension agents. Educated farmers can deal with technical recommendations. Literate farmers can interpret information to perform many jobs.

14. Household size emerged as one of the best predictors of the adoption of cocoa technologies. The farm household, therefore, contributed significantly to cocoa production. Any meaningful development program should center on the household. It is essential that the institutions serving the cocoa sector (especially research and extension) address the technology and related needs of the household, so that household members will contribute their quota to the production of cocoa.

15. Credit availability was an important aspect of the cocoa technology adoption. It is, therefore, critical and important that policy makers, planners, and implementers of cocoa extension programs focus more attention on the availability of credit to farmers.

Recommendations

Based on the findings, discussion and conclusions of the study, the following recommendations are presented to improve the dissemination and adoption of cocoa production technologies:

1. Cocoa research and extension should focus on the development and dissemination of low cost, low external input technologies and by relying minimally on purchased inputs.

2. Extension organizations should educate farmers on the need for proper post harvesting handling techniques, particularly, fermentation, drying and grading of produce.

3. The Ghana Cocoa Board should actively be involved in cocoa extension. The cocoa extension unit of the Board should be revitalized and be sufficiently flexible to encourage and accommodate local initiatives to meet local peculiarities

4. It is necessary to improve the extension services through better service conditions and improved supervision. The extension worker-farmer ratio should be drastically reduced to ensure adequate coverage.

5. Extension personnel need to receive professional in-service training in technical subject matters or technical packages. Systematic training needs assessment and tasks analysis for staff training programs should be conducted regularly to determine, which new technologies or subjects are to be offered.

6. Extension training should also cover strategic planning, management principles and message design. Training in cost-benefit and risk-payoff analysis of technologies, management information systems and communication technology application will ensure efficient and effective extension service delivery

7. With majority of farmers preferring group-teaching methods, teaching and communication tools and aids such as projectors and public

address systems should be available so that extension workers can use more group approaches. Radio is certainly a powerful communication tool for development in the present situation. Radio stations should see farm broadcasts as public service and not hindered by exorbitant charges for airtime.

8. The extension service should also exploit alternative communication channels within the communities. There is a clear need for the development of functional farmers' association in the study areas, not only as a communication channel, but also for mobilization for socio-economic empowerment.

9. A multi-disciplinary team of personnel should plan, implement and manage cocoa extension programs. This will require practical and workable functional linkages and collaborations among relevant agencies. These include staff dealing with cocoa research and technical subject matters. Others are extension, input firms and communication support agencies. The rest are concerned government and non-government organizations.

10. The extension services should know and understand the personal and background characteristics of the farmers they serve. They should also understand the socioeconomic and farm-related factors under which farmers operate. Extension agencies should and be able to take advantage of these in designing strategies to reach farmers effectively.

11. Majority of farmers were aged or ageing. Therefore, to revamp the cocoa industry require measures that will encourage the youth to take up cocoa farming. The measures should include the provision of social

amenities such as electricity, water, clinics, schools and good roads in the rural areas. Young farmers in the study need more agricultural knowledge, skills and positive attitudes. This calls for heavy investments in youth extension programs. Agricultural extension organizations should organize and support rural youth clubs and/or young farmers programs. Special support programs and incentives will make the youth take up cocoa farming as a profession. Such measures could also possibly provoke an earlier transfer of land from the older to the younger generation.

12. The literate cocoa farmers in the study should be fully aware of appropriate extension publications, for example, guides, leaflets and posters in local languages. Continuing to increase cocoa production through the use of improved technology will require an increasing level of education on the part of rural people.

13. Women played an important role in cocoa production. They made up of one-third of farmers in the study. In the case of the Training and Visit System, women farmers should be fully represented as contact farmers in each village. These women contact farmers, in turn, should be strongly encouraged to discuss the impact points (technical recommendations) with other women farmers in their respective communities.

14. The internal marketing of cocoa need improvement by ensuring prompt payment of produce and proper record keeping by local buying companies. Buying companies should monitor the accuracy of weighing scales to ensure transparency and price-efficiency.

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15. The Akuafo cheque system should be maintained and all buying companies made to operate it.

16. Production-enhancing inputs were available in the cocoa growing areas, thanks to the current Cocoa Diseases and Pest Control and Hi-tech Programs. It is recommended that the government sustain these programs. Farmers should also adopt integrated pest management to decrease the heavy reliance on chemical inputs.

17. Where production has to increase with the same amount of labor and where cocoa farming has to compete with more attractive sources of income, solving labor problem could be the harnessing of available local 'nnoboa' system. Mechanization could also alleviate labor bottlenecks.

18. The essence of credit to farmers is to enable them to properly maintain their farms in anticipation of better returns. Incentive oriented policies such as bonuses and credit facilities with terms of payment, which take into consideration cash flow of cocoa farmers would be esse[illegible] sustain cocoa cultivation. Ghana Cocoa Board could provi[illegible] money to the banks and buying companies for lending to farmers at [illegible] lower interest rates to purchase farms inputs for farm maintenance.

19. There is the need for intensive education to enhance farmers' awareness that investment in their farms can be recouped with reasonable profit if research and extension recommendations are followed. This is one way farmers can reap the full benefits of their labor and help to make cocoa production sustainable in the country, dependent as it is on numerous smallholder farmers.

20. Government should primarily continue to act as enabler, supporting an array of agents from private sector, farmers' associations, NGOs and other organizations. In order for this to lead to genuine impact, extension should go beyond the unified extension system to provision of support to the production context. A major role of the state as enabler will be to empower farmers to meet their technological needs and to make effective demands on providers of extension, inputs, marketing agencies and other services.

Suggestions for Further Research

The section deals with suggested areas for further research. They include the following:

1. There is the need for further research to determine the composition of the farm households and the role and contribution of each member in the adoption process.
2. It is necessary to take a more critical look at the credit delivery to cocoa farmers in the country
3. Further study is required in time to show the general trend of adoption and to extend the study to cover other districts in the country.

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APPENDIX I

Cocoa Production Technology Dissemination and Adoption in Ghana

Questions for Farmers

Region

District ....

Village ....

General Guidelines

Please, fill in the blank spaces .... or mark X where applicable, in the parentheses provided near the answer provided

Technologies Involved In the Establishment and Maintenance of Cocoa

Site selection

1 Why did you select the particular site for cocoa cultivation?

- a Ideal weather condition ( )
- b Good soil ( )
- c Forest land ( )
- d Land availability ( )
- e Accessibility ( )
- f Other Please, state ....

2 Did you conduct soil analysis on your land before establishing your farm?

1 No ( ) 2 Yes ( )

If no, why not?

a Not aware of importance ( )

b Not necessary ( )

c Cannot afford cost ( )

d. Do not know how to go about it ( )

e Other, specify

Land preparation

3 How did you prepare your land before planting?

a Cleared weeds and stumps ( )

b Burnt weeds and thrash ( )

c. Removed stumps ( )

d. Other, specify . . . .

Shade

4 How did you establish temporary shade?

a Planted food crops, specify, plantain ( )

Coco yam ( )

Cassava ( )

Others. . . . .

b Planted fast growing trees like *Glyricidea sp* ( )

c No temporary shade provided ( )

5 How many permanent shade trees did you leave on the land per hectare?

a 0 - 5 ( )

b 6 - 10 ( )

c 11-15 ( )

d More than 15 ( ) e. None ( )

Spacing

6. What spacing did you use?

   a 10 feet by 10 feet ( )

   b 8 feet by 8 fee t ( )

   c Random planting ( )

   d. Other. ....

Planting

7. When did planting take place?

   a May ( )

   b. June ( )

   c. July ( )

   d. August ( )

   e. September ( )

   f. October ( )

8. How did you plant your farm?

   a. Planted seeds at stake ( )

   b. Transplanted seedlings ( )

   c. Both ( )

9 Did you line and peg your land before planting?

   1. No ( ) 2. Yes ( )

10. Which planting pattern did you adopt?

a. Square ( )

b. Equidistant triangle ( )

c. Staggered arrangement ( )

d. Other, specify

Planting Material

11. Where did you get your planting materials?

a. Farmer's farm ( ) b. own nursery ( )

c. Private nurser ( ) d. Seed Production Unit of COCOBOD ( )

Weeding

12. How many times did you weed your farm last year?

a. Once ( ) b. Twice ( ) c. Thrice ( )

d. Four times ( ) e. More than four times ( )

f. No weeding ( )

13. How did you control weeds on your farm?

a. Cutlass weeding ( ) b. Machine weeding ( )

c. Weedicide application( ) d. Hand weeding ( )

e. Other, please state...............................

Pruning

14. Did you prune your cocoa trees last year? No ( ) Yes ( )

15. What tool did you use in pruning?

a. Cutlass ( ) b. Standard pruner ( ) b. Hand saw ( )

c. Other, specify ....

16. Did you remove unwanted basal chupons from the cocoa trees?

1. No ( ) 2. Yes ( )

3. Removed some ( )

Fertilizer Application

17. Did you apply mineral fertilizers? 1. No ( ) 2. Yes ( )

Pests and diseases control

18. Did you spray your farm against pests last year?

1. No ( ) 2. Yes ( )

If yes:

How many times?

a. Once ( ) b. Twice ( )

c. Thrice ( ) d. Four times ( )

In which months?..

If no, why not? ....

19. Does your farm suffer from Black pod disease?

1. No ( ) 2. Yes ( ) 3. Not aware

If yes, how do you control it?

a. Remove infected pods( ) b. Reduce shade ( )

c. Provide adequate drainage ( )

d. Other, specify ....

20. Do you use fungicides to control Black pod disease?

1. No ( ) 2. Yes ( )

21. Does the swollen shoot disease occur on your farm?

1 No ( ) 2 Yes ( )

3 Don't know ( ) 4 Not aware of the disease (

If yes, how do you control it?

a. Uproot infected and surrounding trees ( )

b. Call in CSSVD workers to treat ( )

c. Cut off the affected parts ( )

d. No control ( )

Harvesting

22. How often do you harvest your crop?

a. Any time pods are ripe ( )

b. When most pods are ripe ( )

c. When all pods are ripe ( )

d. Every week ( )

e. Fortnightly ( )

f. Monthly ( )

Other, specify

23. How long after harvesting do you open the pods to remove the beans? days

24. How do you break the pods to remove the beans?

a. Use wooden club ( )

b. Use machete ( )

c. Use machine ( )

d. Knock pods on the ground ( )

e. Knock pods together ( )

f. Other, specify

Fermentation

25 How do you ferment your cocoa beans?

a. In baskets ( )

b. In boxes ( )

c. In heaps on plantain leaves ( )

d. Other, specify ....

26. How long do you ferment your beans? ....days

27 How often do you stir the beans during fermentation?

a. Every 48 hours (days) ( )

b. Every 24 hours (daily) ( )

c. Every 12 hours ( )

d. No stirring of beans ( )

Drying

28 What method do you use in drying your beans?

a. Spread on mats placed directly on the ground ( )

b. Spread on bare cement floor ( )

c. Spread on mat raised on supports ( )

d. Spread on plastic sheet raised on supports ( )

e. Spread on plastic sheet placed on the ground ( )

f. Movable roof dryer ( )

29 How do you store your cocoa beans before sales to the LBC?

a. In jute sacks ( )

b. In baskets ( )

c. In fertilizer bags ( )

d. Crates ( )

Other, please, state ....

How do you transport your produce to the Local Buying Company?

a. Carry produce in head loads ( )

b. Vehicle ( )

c. Other, please state ....

30. Are your cocoa beans graded before sale? 1. No ( ) 2 Yes ( )

31. Details of farm

Size (Hectare 2.471 acres)	When did you start cultivating on this farm? *(Indicate year)*

Communication Factors Involved in the Dissemination of Technologies

32. Do you know that cocoa extension is now under the Unified Extension Service of the Ministry of Agriculture? 1 No ( ) 2 Yes (

33 In your opinion, who should take charge of cocoa extension?

(a) Ministry of Agriculture ( )

(b) Cocoa Services Division ( )

(c) Cocoa Research Institute ( )

(d) Private Firms ( )

Other, specify ....

Please, give reasons for your choice..

34. Do you know the Agricultural extension worker in charge of this village?

1. No ( ) 2 Yes ( )

34. How often does the agricultural extension worker visit you/cocoa farmers of this village?

(a) Never ( ) (b) Fortnightly ( ) (c) Monthly

(d) Quarterly ( ) (e) Occasionally (

(f) Bi-annually ( ) (g) Once a year ( )

35. When was the last time you saw the agricultural extension worker in this village?

(a) Less than 2 months ( ) (b) 3-6 months ( )

(c) 6-12 months ( ) (d) Over a year ago (36. How long have you been working with agricultural extension agents in your village?

(a) Not yet ( ) (b) Less than 3 years ( ) (c) 3-6 years( )

(d) 7-10 years ( ) (e) Over 10 years ( )

37. How do you get information on cocoa production?

(a) Office call ( )

(b) Telephone call ( )

(c) Personal contact ( )

(d) Seminar/symposium/workshop ( )

(e) Group meetings ( )

(f) Demonstration ( )

(g) Print materials ( )

(h) Other, specify ....

38 Which ones do you prefer most? ....

Give reasons: ....

39. Kindly, rank in order of preference extension methods used in training farmers in your village

Method	Preference scale				
	Most preferred	Next preferred	Somewhat preferred	Least preferred	Not preferred
Group discussion	5	4	3	2	1
Demonstration	5	4	3	2	1
Lecture	5	4	3	2	1
Office call	5	4	3	2	1
Home visit	5	4	3	2	1
Radio	5	4	3	2	1
TV	5	4	3	2	1
Field trip	5	4	3	2	1
Print materials	5	4	3	2	1
Seminar/Workshop	5	4	3	2	1

40 What information do you seek on cocoa production?

(a) Site selection ( )

(b) Planting materials ( )

(c) Site preparation ( )

(d) Lining and pegging ( )

(e)	Establishment of nurseries	( )
(f)	Cultural practices	( )
(g)	Supply of inputs	( )
(h)	Diseases and pests control	( )
(i)	Harvesting	( )
(j)	Fermentation	( )
(k)	Drying	( )
(l)	Quality control	( )
(m)	Marketing	( )
(n)	Other, specify..	

41. Apart from Ministry of Agriculture extension agents, which of the following promote cocoa extension in this village?

(a)	Cocoa, Coffee, Sheanut Farmers' Association	( )
(b)	Private Firms	( )
(c)	Marketing Firms	( )
(d)	NGOs	( )
(e)	Other Farmers' Organization	( )
(f)	Cocoa Research Institute of Ghana's Researchers	( )
(g)	Church Organizations	( )
(h)	Agro business Firms	( )
(i)	CSSVD Control Unit Staff	( )
(j)	Other, specify..	

42. What recommendations would you make for improving the effectiveness of cocoa extension delivery?..................

....

43 Kindly, rank in order of preference the extension approach that extension agents must adopt during their interaction with farmers (Please circle the number, which corresponds to your preference)

Extension Approach	Preference scale				
	Most preferred	Next preferred	Somewhat preferred	Least preferred	Not preferred
Production technology	5	4	3	2	1
Problem-solving	5	4	3	2	1
General	5	4	3	2	1
Commodity-specialized	5	4	3	2	1
T&V	5	4	3	2	1
Other, please, state					

Adoption of Technologies

44 Which of the following technologies have you adopted on your farm and which year did you adopt?

	Technology	No	Yes	Year
a.	Soil test	( )	( )	
b.	Essential temporary shade	( )	( )	
c.	Permanent shade	( )	( )	
d.	Row spacing	( )	( )	

e.	Line and pegging	( )	( )
f.	Use of hybrid seed	( )	( )
g.	Nursery raised seedlings	( )	( )
h.	Seedlings raised in polybags	( )	( )
i.	Optimum crop density (1500 plants/hectare)	( )	( )
j.	Shade manipulation	( )	( )
k.	Regular weeding	( )	( )
l.	Use of herbicide	( )	( )
m.	Pruning cocoa trees	( )	( )
n.	Removal of basal chupons	( )	( )
o.	Removal of mistletoes	( )	( )
p.	Use of standard pruner for mistletoe control	( )	( )
q.	Mineral fertilizer application	( )	( )
r.	Use of insecticides to control pests	( )	( )
s.	Use of fungicides to control diseases	( )	( )
t.	Provision of adequate drainage	( )	( )
u.	Swollen shoot disease control	( )	( )
v.	Regular harvesting of ripe pods	( )	( )
w.	Burying all pod debris after pod breaking	( )	( )
x.	Fresh beans undergo fermentation	( )	( )
y.	Stirring of beans during fermentation	( )	( )
z.	Beans spread on plastic sheet for drying	( )	( )

45. Kindly, mention problems that hinder the adoption of technologies?

....

46. What recommendations can you make to ensure adoption of technologies by farmers? ....

Farm Resources

Labor

47 Kindly, indicate sources of labor for your farm operations

a. Family ( )

b. Caretaker ( )

c. Hired (daily paid basis) ( )

d. Hired (Annual paid basis) ( )

e. Shared cropper ( )

f. Other, specify ....

46. Is communal labor (*nnoboa* system) in existence in this village?

No ( ) 2 Yes ( )

49 How would you access the availability of hired labor in your area for farming operations?

(a) Very easy to come by ( )

(b) Easy to come by ( )

(c) Difficult to come by ( )

(d) Very difficult to come by ( )

(e) Not available ( )

50. Do you normally travel outside your village to seek for laborers?

1. No ( ) 2 Yes ( )

If yes, indicate how far you have to travel outside your area to seek for laborers.............Km

51. Do you provide any food or farm produce in addition to labor charges?

1 No ( ) 2 Yes ( )

If yes, what is the value of the food provided per laborer per day? cedis

52 What is your perception of the cost per day in your area?

(a) Very high ( )

(b) High ( )

(c) Moderate ( )

(d) Low ( )

(e) Very low ( )

53 Equipment/Machinery

Equipment/Machine	Code	Do you owe any of the equipment below? 1 No 2 Yes	How many	Do you rent/borrow any of the equipment below? 1 No 2 Yes
Vehicle	1			
Wheelbarrow	2			
Chain saw	3			
Hand sprayer	4			
Mistblower	5			
Standard pruner	6			
Harvester "Go to hell"	7			
Earth chisel	8			

Credit

54 Do you ever borrow money ..?

(a) For your farm work? 1 No ( ) 2 Yes ( )

(b) For other use? 1 No ( ) 2 Yes ( )

If you never borrow, what is the reason? ....

55. How difficult is it to get credit when most needed?

1. Very easy ( ) 2. Easy ( ) 3. Difficult ( ) 4. Very difficult ( ) 5. Cannot say/tell ( )

56. a) What are your sources of credit? ...

b) For what purpose did you receive any loan?

1. Land ( ) 2. House ( ) 3. Seedlings ( ) 4. Chemicals ( )

5. Not applicable ( )

6. Other, specify...

57. Did you save any money from the sale of your produce last year?

1. No ( ) 2. Yes ( )

58. Do you have a bank account?

1. No ( ) 2. Yes ( )

If yes, what account?

1. Akuafo cheque account ( )
2. Credit Union ( )
3. Savings ( )
4. Current ( )

59. What has been the major problem in credit acquisition?

(a). High interest rate ( )

(b) Cumbersome processing procedure ( )

(c) No collateral ( )

(d) Not applicable to me ( )

Other, specify...

Land Tenure

61. State the terms of land acquisition for your cocoa farming?

(a) Leasehold ( )

(b) Gift ( )

(c) Family ( )

(d) Titled ( )

(e) Sharecropping ( )

(f) Pledge ( )

(g) Inherited ( )

(h) Rental ( )

(i) Citizen's right to land ( )

(j) Purchase of land for development into a cocoa farm ( )

(k) Purchase of an established cocoa farm ( )

(l) Other, specify...

If sharecropping.

What are your obligations? ....

61. How are harvests divided between sharecropper and landowner?

a. Abunu ( )

b. Abusa ( )

c. Other, specify..

62. How many kilos of dried cocoa beans did you get from your farm in the last three crop seasons?

2001/2002	2002/2003	2003/2004

63. Do you know how the government fixes the price of cocoa?

1 No ( ) 2 Yes ( )

If yes, explain..

64. Have you sold *abinkyi* beans before?

1. No ( ) 2. Yes ( )

65. Do people come and buy cocoa in this village from the neighboring country?

1 No ( ) 2 Yes ( )

66 Did farmers in this village smuggle cocoa to neighboring countries last season? 1. No ( ) 2. Yes ( )

67. Which Local Buying Companies buy cocoa in this village?

a. Produce Buying Company ( )

b. 'Ajumapa' ( )

c. Agro trade ( )

d. Olam ( )

e. Gold Crest ( )

Others specify..

68 Which of the above did you sell your cocoa to in the last season?

a. ....

b ....

c. ....

69. What did you receive for payment of your produce?

a. Cash ( )

b 'Akuafo' cheque ( )

c. Both ( )

70. Did you receive bonus last year?

1. No ( ) 2. Yes ( )

71 Kindly suggest ways to improve the internal marketing of cocoa

....

Background Characteristics of Farmer

72. Name...

73. Sex: 1. Male ( ) 2. Female( )

74. How old were you at last birthday? .... years old.

75. Can you read and write?

(a) English 1. No ( ) 2. Yes( )

(b) Vernacular 1. No ( ) 2. Yes( )

76. How far did you reach in school?

(a) No formal education ( ) (e) Bachelor's Degree ( )

(b) Middle School/JSS ( ) (f) Master's Degree ( )

(c) GCE/SSS ( ) (g) Doctor's Degree ( )

(d) Post-Secondary ( ) (h) other, spiffy..........

77. Have you attended any short course on cocoa production before?

1. No ( ) 2. Yes ( )

If yes, where?

(a) Cocoa Station ( )

(b) MOFA Office ( )

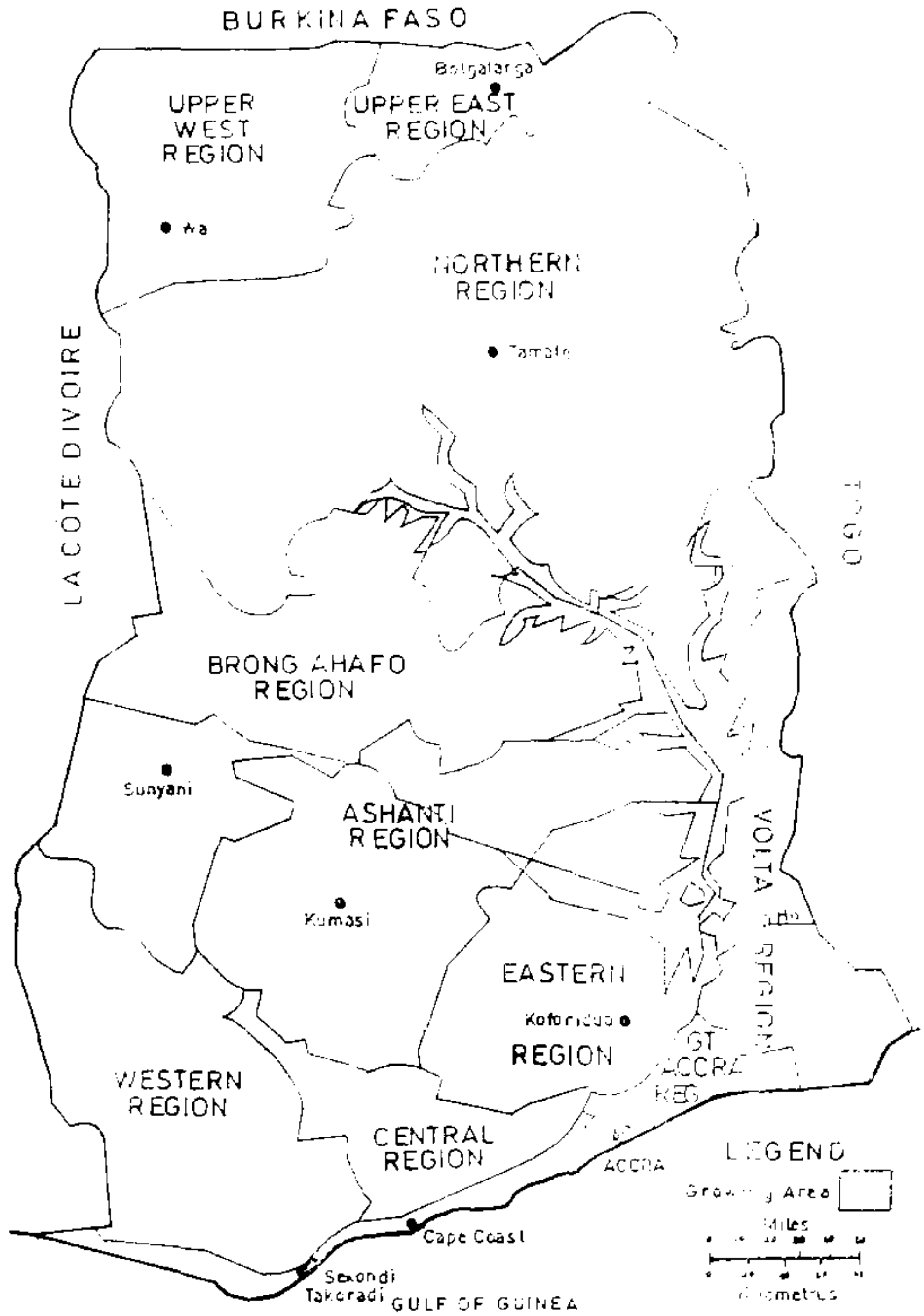
(c) CRIG ( )

(d) Bunso Cocoa College ( )

(e) Other, specify.........

78. How long have you worked as a cocoa farmer? .... years

79. How many members are there in your household?



Appendix 2: Map of Ghana Showing the Cocoa Growing Belt

Appendix 3: District Map of Ghana Showing the Study Area