An empirical analysis of risk aversion among small holder farmers in Nigeria

Thesis By

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ABSTRACT

This study examines the extent to which incorporation of attitudes toward risk in farm planning helps farmers to plan for crop production; and policy makers, to appreciate farmers' response to policy decisions. It provides some quantitative information on risk attitudes of farmers under "the safety-first principle" and Expected Income - Absolute Deviation (E-A) criterion. The relation between measured risk coefficients and socio-economic characteristics of the farmers was also examined.

Both primary and secondary data were utilized for the study. The primary data were collected from the farming population in three strategically located Agricultural Development Project areas in Nigeria: The Bauchi ADP which covers part of middle belt and the Northern Agricultural zone, the Oyo ADP located in the Western zone and the Imo ADP in the Eastern Agricultural zone of the country. The secondary data were obtained from the past records of Defunct Oyo North Agricultural Development Project (ONADEP), past studies in the project area, publications of the Federal Office of Statistics and Federal Ministry of Budget and Planning Lagos (now National Planning Commission).

The analytical approaches adopted for the study were the Target-Minimization of Total Absolute Deviation (T-MOTAD) and multiple Regression technique. The Target-MOTAD model was constructed to get data to elicit risk coefficients for the farmers and to analyse the expected return-risk trade-off for the farmers subject to a targetted minimum level of income. Also a simple analytical method through ranking was used to elicit farmers' subjective judgement of risk in crop production.

Sole cowpea enterprise was identified as the most risky enterprise while planting mixed crops lowers risk considerably. It was shown that by increasing Credit and by optimizing and including better crops, farmers can increase the net return than they are presently taking. Risk level of farm plans increases as expected return increases.

Five socio-economic variables were identified to be particularly significant in influencing the farmers risk behavior. Age and family size have negative impact on risk while farm income off farm income and loan procurement have positive influence on risk taking disposition of the farmers.

These variables are all significant at five (5) percent level of significance.

The study concluded that the problem of the small scale farmers is not their inability to take risk but in the lack of information about opportunities available for making necessary decisions under uncertainty. The study recommended, among other things, improvement of extension services, extension of crop insurance scheme to cover all crops, introduction of new varieties of seeds, and continuous use of fertilizers and insecticides to offer the farmers a better base to hedge against risk.

DEDICATION

To God who makes all things possible and to my parents; Mr. S. A. Adubi and Deaconess A. E. Adubi for giving me the lifetime opportunity of being educated.

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A. A. ADUBI

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CERTIFICATION

I certify that this study was carried out by **MR. A. A. ADUBI** in partial fulfillment for the Ph.D. degree in Agricultural Economics under my supervision.

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CHAPTER I

INTRODUCTION

1.1 Traditional Agriculture and Risk

Risk is a pervasive phenomenon in any economic activity. It is particularly important in traditional agriculture where it affects production decisions and adoption of technology among others. Many factors including weather, diseases, insect infestations, general economic conditions, the development and adoption of technological innovations, public and private institutional policies interact to create a unique decision making environment for the agricultural producer.

Production decisions are generally made under this environment of risks and uncertainties. Product prices, yield and to a more limited extent, input prices and quantities are usually not known with certainty when investment decisions are being made. In many cases, farmers are confronted by risk of pests and diseases during the cropping season. For instance, crops may be totally destroyed by fire, drought, pests and diseases or product prices may decline. Such characteristics result in returns displaying high variability or farm incomes which are unstable and which vary with the farming system and with the climate, policy and institutional setting and so on.

Agricultural risks seem to be prevalent throughout the world, but they are particularly burdensome to small farmers in developing countries. In Nigeria, these farmers constitute the bulk of food crop producers and are mainly relied upon for up to 95 per cent of food supply in the country. Production inputs for these farmers consist of land and family labour; capital investment is negligible; modern biological inputs such as fertilizers and chemicals are seldom used. Infact, the rural environmental setting (with little or no basic amenities) in which they live and operate does not facilitate effective communication and diffusion of agricultural information. In addition, the cultural background, norms and beliefs prevent faster adoption and diffusion of new technologies. Opportunities and access to information are limited and average distance from house to farm ranges from five to ten kilometers. These characteristics make the farmers inadequately equipped against risk and uncertainties.

The production of the small farmers is mainly for subsistence while little surplus is taken to the market as marketable surplus. In other words, family consumption overrides other considerations in production decision. Their production is therefore less market oriented with the primary objective of balancing family food requirements with the need for cash income. As a result, the peasant farmers are particularly cautious in deciding on types of crops to plant, the cropping system to adopt and the distribution of available resources among enterprises (Olayemi, 1980). This implies that the farmers will be reluctant to change their more stable, lower return traditional techniques for a riskier, more profitable technology on the farm.

It is, therefore, not surprising that many agricultural policies since Nigeria's independence in 1960 have been directed toward improving these small farmers production methods and equipping them against risk through adequate use of improved technology embodied in a package approach. The package consists of high yielding and resistant varieties of crops and livestock, modern techniques of farming, fertilizers, herbicides and improved storage methods and extension services.

Efforts have been concentrated on transferring some adverse effects of price and yield variabilities from the farmers to government. The creation of Agricultural Insurance Scheme testifies to this fact and several researches have been conducted on this method of minimizing risk in traditional farming (Adeyeye and Akinwunmi, 1978, Mabawonku, 1986). Given these concerted efforts at minimizing risks in peasant agriculture, the behaviour of the small farmers in situation of risk constitutes an important consideration for research.

One hypothesis often advanced to explain small farmers behaviour under risk is the safety first criterion (Roy 1952, Roummasset, 1979, Tauer, 1983 and Berbel, 1990). This hypothesis suggests that the farmer's attitude to risk is to first cultivate the crops (and also raise the livestock) that he, from experience, expects to guarantee the provisions of minimum income needed for his family's survival. Minot, 1986) noted that any change that threatens this status-quo, especially those which come into direct conflict with the fundamental goal of security to generate income to cover subsistence needs, must take into account the degree of risks and uncertainties associated with the change. Baker, 1987) also noted that the lower expenditures on cash inputs by small farmers may be a reflection of their inability to obtain credit but appears to have been more directly influenced by the higher risk involved in farms depending on rudimentary technology.

The foregoing presupposes the existence of and a conflict between two goals: Profit and Security. The farmers are more sensitive to income variability and often exhibit high aversion to risk. They seek to avoid risk through various managerial and institutional mechanisms, for example, they may diversify their crop production, favour traditional techniques using less modern inputs or enter into share cropping arrangements or future price arrangements. On the other hand, these farmers also want to improve their farm income which definitely come with greater risk. This conflict justifies the need for a study to understand farmers behaviour under risk. In fact, the knowledge of farmers attitude to risk is important to policy formulation for a number of reasons.

First, fluctuations in farm incomes particularly the risk of catastrophic losses present welfare problems for rural people. Reduced farm income also has a negative multiplier effect on income distribution and employment among the producers and traders of rural consumer goods and services.

Secondly, exposure to severe risk increases the likehood that farmers will default in repaying bank loans. Furthermore, farmers try to avoid risk through management practices that reduce average return to their resources. This reduction in farm incomes also leads to lower elasticities of supply for agricultural commodities. Finally, farmers allocate their resources based on their expectation of yield and prices. If these expectations are wrong, their resource allocation will be less than optimal.

In a world which conforms to the assumption of neoclassical economics, where every decision is expected to be made with perfect knowledge and more is always preferred to less, it is a simple matter to predict and prescribe decision making behaviour. Once we relax these assumptions and introduce uncertainty with respect to the outcomes of action choices, the decision maker's behavior cannot be predicted without some knowledge of his perception of the distribution of outcomes from available action choices, attitude toward risk and preference for additional income. Successful policies aimed at improving agricultural production must therefore include consideration of farmers' attitude toward risk.

1.2 Risk versus Uncertainties in Farm Production

The farm operator or producer normally faces two eventualities whose outcomes modify the production relationships in view of their strong bearings on future plans, yields, prices and net income. These are Risks and Uncertainties (Olayide and Heady, 1982).

Risk refers to variabilities which are measurable in an empirical or quantitative manner. The variability or outcome need not be exactly predictable for any given product or output but the probability of outcome or loss must be capable of being established either by use of prior probabilities (when the characteristics of the eventuality are known beforehand) or by statistical probability of outcome based on large samples of cases or replicable observations which are randomly and independently distributed. This possibility of empirical probabilities makes risk situations insurable in an actuarian sense. If the frequency distribution or parameters of the probability distribution of risk outcomes can be established, it then means that we can fairly accurately establish the mean, mode, skewness, kurtosis and variance or other measures of dispersion with an empirical probability of 1 for any particular distribution. But what forms of risk situation do we find in farm production and how amenable are they to actuarian convention and payments? Farm eventualities classified as risks include the year-to-year variabilities in crop yields that are normally associated with fluctuation in weather. Such variabilities may be classified as risk in farming communities where the climate is fairly stable or the simple range of yield is repeated frequently enough to enable the farm operator establish the mean or modal outcome and the range or variance of outcomes. Variabilities in yield income due to risk can be minimized by measures designed to alter production plans. These include farm insurance program, diversification policies, maintaining flexibilities in production etc. In peasant economies oriented to subsistence farming with some marketable surpluses, socio-economic studies have shown that variabilities arising from risk are known to be minimized by such practices as diversification, multiple or mixed cropping and multiple or scattered farm plots.

Uncertainty, is an event in which we cannot establish the probability of an outcome in an empirical or quantitative manner. Here we have a situation where the knowledge of the future is less than perfect in the sense that the parameters of the probability distribution such as mean, mode, median, range, variance, skewness, kurtosis cannot be determined.

Uncertainty therefore becomes a subjective knowledge situation and we can only work with anticipations of the future. Several parameters of expected or subjective probability or frequency distribution are capable of serving as useful measures of uncertainty or chances of loss in such a situation.

Uncertainty may result from one or a combination of four factors which may be endogenous or exogenous. These are price uncertainty of factors of production or farm output, yield uncertainty, which eventually refers to variability in production coefficients for a given technique, technological uncertainty which leads to variabilities in the prices of outputs of farm products and socio-legal uncertainty in which the farm operates. For example, law specifying compulsory primary education for all children above six years have been known to have serious impacts on farm labour and farming population in developing peasant economies (Olayide and Heady, 1982).

Also uncertainty may result from political instability in a country. This emanates from instabilities in government regimes, instability of government personnels and instability in government policies. The international environment also creates uncertainties as a result of its unpredictability.

For example, the merging of Eastern and Western Europe will definitely have an effect in the world market; so also will be the outcome of Europe '92 on the international prices of commodities. Lastly uncertainties are also created by direct or indirect action of the public. For example bush burning.

The foregoing gives a simple distinction between Risk and Uncertainty. However, given that the degree of risk or uncertainty of an event often depend on individual's preference, there has been no concensus on the line of demarcation between risk and uncertainties in literature (Roumasset, 1978). Most empiricists depend on the distinction by Knight, 1921). Knight distinguished between Risk and Uncertainty on the basis of amount of information available about the likelihood of outcomes of action choices. If a situation was similar to past occurrence and information about outcome could be used in forming probability density function for the outcome, then the situation is risky. Otherwise the situation is uncertain. He associated objective probability (generated from empirical observations) with risk and subjective probability (ratios of perceived likelihood with uncertainty. But analysts have argued that all information are subjectively perceived, measured and interpreted. Recently therefore, less emphasis is being placed on this distinction and for the purpose of this study, the terms are used interchangeably.

1.3 A Review of the Study Area

The study area covered by this study is the Agricultural Development Project areas located in strategic zones in the country. The Bauchi ADP covers part of the middle belt and the Northern agricultural zone, the Oyo ADP is located in the Western zone while the Imo ADP covers the Eastern agricultural zone of the country. These ADPs were chosen in order to get a geographical spread and to obtain a sample that is representative of the small scale peasant farmers in the country. Furthermore, these ADPs were among the enclaved ADPs and have been in existence for a long time to have imparted their technology on the farmers in the area.

The Northern part is characterized by gently rolling plains rising from some 200m in the south-west to 500m in the north-east. Average slopes are from 2-6% with a flatter topography and consequently poorer drainage in the North. The vast majority of the soils in the area are slightly acid loamy sands underlain by sandy clay loams or sandy clays.

The cation exchange capacity, total exchange bases, and nutrient status are all low. Consequently, the agricultural potential is only fair and with existing techniques, most of the soils cannot stand continuous cropping. However, there are localized patches of stronger soils, many of which are underutilized due to lack of access.

1.3.1 Rainfall and Ecology

Annual mean and total rainfall vary from 1,100mm in the north to 1,200mm in the south, although local topography effects do influence the totals. Most of the precipitation occurs between March and October and is only partially bimodal with a limited drier period in July/August in the South, which is even less marked in the north. Rainfall analysis reveals excellent possibilities for single cropping. However, a long season followed by a short season crop (possibly interplanted) is a distinct possibility.

Within the country, there are two distinct ecological zones, the western moist forest to the south, and the immediate savannah to the north. The study area lies within the broad savannah transition zone separating the southern rain forest from the northern semi-arid sudan zone. Vegetation is generally derived savannah with variations in cover closely linked with edaphic conditions and particularly soil depth and drainage.

1.3.2 Population

The total population is about 700,000 inhabitants based on village listing exercise carried out of the incepts of project. Out of this, 85% or about 510,000 can be considered as rural. Given that the "average" farm family is made up of 6.5 persons, there are an estimated 79,000 farm families in the project area.

Density of the farming population is estimated at 50/km^2 but this varies throughout the project area, for example in the Ifedapo Local Government Area, mainly due to the forest area, average population density is as low as 38/km^2. In general, the agricultural population of the area is stable; outward migration is minimal, and limited to the drift of young males to urban areas. There is some seasonal inward migration mainly from the north and neighbouring Republic of Benin.

1.3.3 Land Ownership Pattern

The basic pattern of land ownership and usage in the project area has been the so-called communal land tenure system, under which traditional leaders are considered to be the custodians of all land in their areas of jurisdiction though the land use decree vested land on the state, and are empowered to grant usufruct to individuals/families.

Theoretically, all lands could be repossessed by the community acting through the chief and traditional elders on the death or departure of the usufructuaries. In practice, however, land is generally inheritable through the family. At the discretion of the head of the family, land can also be divided among family members, or leased out to other families or even to strangers. However, sale of farmland is traditionally frowned upon, or indeed prohibited. Thus, for all practical purposes, communal ownership is effectively exercised only in respect of vacant, virgin or undistributed land.

1.3.4 Land Use, Farm Structure and Farm Enterprises

Existing information, including air photo interpretation, indicates that around 307,000 ha (about 25% of the project area) are cropped within a system of shifting cultivation, the fallow ratio ranging from 1:1 to 1:2 (four cropping years are against 4 to 8 fallow years). Assuming that the expansion in area has at least kept pace with the population increase (average 2.5% per annum) and that the traditional average fallow periods have declined, the area presently cultivated in any one year is about 180,000 ha. (ONADEP 1988). Virtually all of the farms in the project area are owner-cultivated. The few larger farms mostly utilize commercial or government tractor services, and either grow tobacco or some other cash crops. Group farming (average 50 ha per group) is fairly widespread, and the Ministry of Agriculture and National Resources (MANR) as well as Oyo State Investment and Credit Corporation, (OYSICC) credit records show slightly over 100 such farmers' groups.

1.3.5 Crop Production

The bulk of agricultural production comes from manually cultivated rainfed crops. Mixed cropping is common as in other areas of Nigeria. On the average, probably around 60% of crops are planted sole, the balance falling with an intercropped or relay mixture of 2 to 4 crops. The principal annual crops are maize, cassava and yams, representing about 76% of the cropped area. The main cash crop is tobacco, which is cultivated by 2,500 farmers who market their product through the Nigerian Tobacco Company (NTC). (ONADEP, 1989).

The traditional farming system based on shifting cultivation helps maintain fertility and soil structures. The bush fallow rotation usually comprising 3-6 years of cropping is followed by a period of natural fallow (6-10 years). Cultivation practices include the predominant use of hand tools and implements while tractor services are limited and are mainly used by large group or commercial farmers. Use of other modern farm inputs is also extremely limited.

1.4 Research Problem

This study is concerned with the small farmers enterprise combination under risk and their attitudes toward risk in farming. The study area is the Northern part of Oyo State, a region often referred to as Oyo North. The Oyo North area has, in many years been a hive of activities in an agricultural modernization programme of the World-Bank assisted Agricultural Development Project (ADP). The ADP concept started in 1972 as enclaved projects due to failure of special crop programmes to achieve rural development objectives. They were aimed at increasing food production and farm income through the provision of package of farm support services which include improved extension services, on-farm adaptive research, input distribution and varied amount of infrastructure.

In all these programmes, there is reliance on the small scale farmer as the centre piece of an incremental food production strategy (ONADEP, 1982). Also, the anticipated results from the ADP farmers in terms of yield and income were expected to be maxima and had been based on adoption of the technological packages introduced into the enclaved project site. As a result, the small farmer was assumed in most cases to be a profit maximizer whose returns to average resources invested in farming was expected to be optimal. In most farm management studies, therefore, the small farmer is expected to allocate his resources under the principle of profit maximization (Ogunfowora 1974, Durojaiye 1989) despite the violations of the assumptions by the socio-economic setting under which the farmer lives.

It has been observed that the small farmer's actual allocation of resources deviate considerably from the expected. For example, farmers in the defunct Oyo North Agricultural Development Project (ONADEP), now statewide, (OYSADEP) indicated only 30.56 per cent success in predicting resource allocation/output production for yam and 41.93 per cent for maize in 1988 (ONADEP, 1988). Further evidence is shown in Table 1.1 which compares ADP crop achievement with potential yield of crops from adequate use of recommended inputs. It is observed that there is great variance between potential and actual crop yield of farmers.

Given the fact that many factors are responsible for the deviation between expected and actual field results, it is the contention of this study that most predictions, projections and farm planning are made for small farmers without adequate considerations and incorporation of farmers' perception of risks and uncertainties inherent in farming. Moreover the land area devoted to any crop varies from farmer to farmer depending on expectation and subjective probability attached to each crop's success.

Table: 1.1 Potential and Actual Yield of Crops in ONADEP

Crops	Potential Yield Tonnes/ha	1987 Actual Yield of ONADEP Farmers Tonnes/ha	Performance index (%)	1988 Actual Yield of ONADEP Farmers Tonnes/ha	Performance index (%)
Maize	5.380	1.021	18.97	1.12	20.81
Sorghum	2.242	1.024	45.67	1.073	23.42
Yam	45.941	9.569	20.82	10.763	34.3
Cassava	40.173	8.70	21.65	10.484	26.09
Cowpea	2.690	0.423	15.7	0.343	53.8
Melon	0.560	0.28	50.0	0.301	53.8

Source: (i) FOS (Lagos - Rural Economic Survey of Nigeria RES/3/1982, November, 1982 (Column 2)

(ii) ONADEP, 1986, 1989, Activities, Targets and Achievement 1983 - 1989 (Colums 3, 5)

Many empirical studies have highlighted the importance of risk on decision making of the farmers, such studies are Olayide, 1968, Dillon and Anderson, 1971, Lin, Dean and Moore, 1974, Falusi, 1979, Young, 1979, Akinyosoye, 1981, Mabawonku, 1986, Atobatele, 1986, Pannel, 1990, Foster and Rauser, 1991). The farmer's perception and attitudes toward risk to a large extent determines his resource allocation and consequently his adoption of improved technologies and outcome of rural development programmes. Therefore, the limited success of Nigeria, in rural development programmes may be due to the absence of a prior analysis of attitudes toward risk inherent in new technologies and rural development programmes (Wilson, 1968), Uwakar, 1980, 1981). This may also be responsible for the failure of farm management studies to predict farmers actions and decisions more accurately.

Although in farm management studies in Nigeria, there is a spate of literature on the application of linear programming to examine the potentialities of improving the production of these small farmers under condition of certainty, yet, there is little evidence of much efforts to enquire into the possibilities for maximizing returns under conditions of uncertainty. As the world of reality is marked by uncertainty due to variability in yield and prices, maximizing farm returns under these conditions by suggesting an efficient enterprise system is considered as one of the important ways to improve the growth prospects of the farm firms.

This study is a step in this direction. It examines the extent to which the incorporation of attitudes toward risk in farm planning help farmers to plan for land area needed for cultivation and policy makers, to predict farmers' responses to policy decisions. It therefore relates farmers' perception of risk to their socio-economic characteristics and environment. The approach follows from the convention that the degree of risk manifested by individual farmers can be derived from observed behaviour (Moscardi and de Janvry, 1977, Berbel, 1990). Thus, for a farmer with given productive resources, the way those scarce resources are allocated among enterprises on the farm shows his perception of risk inherent in each enterprise. In other words, given a production technology and the risk associated with production and market conditions, the observed level of factor use reveals the underlying degree of risk preference (Norman, 1973, Moscardi 1977, Fleisher and Robison, 1985, Pannel, 1990). Such information may promote farm plans which match the objectives of the farmers better than the traditional profit maximizing plans. Also when used in a planning framework, it may help predict accurately what action the farmer will take in a given situation.

Similar studies have been carried out for small farmers in Nigeria (Norman, 1973, Zuckerman, 1979, Mabawonku, 1986) Mexico, (Moscardi and de-Janvry, 1977) Brasil, (Dillon and Scandizzo, 1978). India (Binswanger, 1980) and Australia (Bond and Wonder, 1980, Hamal and Anderson, 1982). In these studies, it was highlighted that an important motivating force for the farmer in managing productive resources that he controls and particularly in choosing among technological options is the security of generating net-returns large enough to cover subsistence needs. This is the safety-first concept which was first investigated by Roy in 1952, improved upon by Young, 1979, Tauer, 1983, Berbel, 1989, and Chavas and Holt, 1990.

This same concept is adapted for this study. Risk is introduced in a model of economic decision making as a safety-first rule. And as studies above highlighted, safety-first tends to be followed whenever the satisfaction of basic needs seemed to be at risk.

1.5 Objectives of the Study

The overall objective of the study is to determine optimal enterprise combinations under risk and examine farmers behaviour in this situation under the safety first principle. The specific objectives are to:

(i) elicit ADP farmers' attitude toward risk in food crop production;

(ii) work out optimum farm plans consistent with the risk farmers face under the safety first assumption;

(iii) examine the nature of the trade-off between return expectation and risk for the farmers;

(iv) appraise and quantify the socio-economic characteristics of the farmer as it affects different behavioural pattern in risk attitudes.

1.6 Justification for the Study

Definitive research work on the farmers attitudes and incorporation of risk and uncertainty under their environment in Nigeria is generally very limited. However, it is obvious through operation, for example of intercropping that the small farmer is influenced by risk and uncertainties in consideration of both his goals and resource allocation. It is therefore imperative that risks and uncertainties should be considered and addressed if the production of small farmers would be improved considerably. (Norman, 1972, Foster and Rauser, 1991).

Spencer, 1973, Hopkins, 1975, Richard et al., 1976, Ogunfowora, 1982, Durojaiye, 1989, have all used profit maximization objective in conventional Linear Programming (L.P) models in different regions of West Africa, in order to determine optimum combination of enterprises given limited production resources. However, each of these studies gave different assumptions and varying degree of nearness to the typical structure of the small farmer environment. Yet a quantitative knowledge of farmers reaction to changing risk situation is of considerable importance in evaluating alternative government programme and policies directed toward stabilization of prices and incomes. Also knowledge of subsistence farmer's choice behaviour is important in terms of both micro and macro strategies for agricultural development (Dillon and Scandizzo, 1978). Several techniques have been developed in order to handle risk in farm planning models (Fleisher and Robinson 1985). Whether the proposed techniques will result in better farm plans and how these plans differ from certainty farm plans however is not well known. This study illuminates these areas and form an empirical basis for making a decision about explicit incorporation of risk in farm planning models.

Elicitation of risk attitudes has two principal uses in the agricultural sector. First, agricultural policy analysis is of limited use if it does not take risk into account. But, microeconomic policy research has not been completely successful in incorporating risk into prediction models. Inability to produce estimates of risk by class and type of farm operation constrains the ability of the policy analyst to predict the effect that agricultural policy initiatives or changes might have on a particular target group.

Secondly in most extension programmes, production, marketing and investment recommendations are often made to farmers without acknowledging the risk inherent in each strategy. Producers can be placed into one of several risk group categories and a set of risk efficient farm plans developed for these categories. The decision maker could then decide which of the plans in the relatively small efficient set is best for him. It can be argued that extension programme could become more effective and responsive to the needs of their primary client group with accurate empirical measures of risk preference. The desire to tailor extension farm management recommendations to the current risk preferences of particular farmers provides one potential justification for measuring risk preferences (Young, 1979).

The dynamic nature of agriculture requires extension agents to know how to analyse and disseminate information concerning new techniques and practices as they become available. For example, new techniques need to be analysed, incorporating farm family objectives and risk behaviour to determine whether farmers can afford to adopt them and if so, what the potential consequences will be on production resource needs and use over time. Estimating single-attribute risk coefficients of peasant farmers and relating them to socio-economic variables is necessary to predict farmers willingness to adopt new technology or participate in rural development programmes.

In the area of microeconomic policy and predictive application, it has been argued that farm management extension and development programme planning applications are justifications for measurement of individual risk preferences.

The studies of Baquet, 1976, Halter and Mason, 1974, Harris and Nehring, 1976, Lin et al, 1974, Chavas and Holt, 1990, provide examples of such applications.

A policy area of particular importance justifying incorporation of risk considerations is the dynamic structural and distributive implications of income instability in agriculture and of public policies to mitigate such instability. The government should be interested in the relationship between risk preferences and structural features especially farm size and legal form of ownership.

1.7 Plan of the Study

The remaining text consists of seven chapters. Chapter II presents the theoretical framework and the development in techniques for risk analysis. An indepth analysis of the concept and approaches to risk measurement is carried out. The importance and impact of the economic environment was also considered. In addition, the section discusses the meaning of safety first criterion which is used later in the study to model farmers behaviour in traditional farming. Chapter III reviews literature and discusses the empirical application of the decision theory. Findings relating to risk management in farmers' environment are critically assessed and related to the current study. Special attention was paid to applications to the developing countries. Chapter IV discusses the characteristics of the study area and research methodology. It specifies the Target-Minimization of Total Absolute Deviation (MOTAD) model used for this study and the corresponding assumptions.

Chapter V highlights the socio-economic characteristics of the farmers in the study area. It elaborates on and compares variables determining, the nature of farmers household such as age, family size etc; his income generating potential such as farm size, farm income etc and his access to formal and informal institutions such as membership of cooperative association, access to loan etc.

In chapter VI, application of the Target-MOTAD model is made to determine the optimum farm plans and resource combinations under risk. A set of efficient farm plans is identified along the computed efficiency frontier. The chapter further illuminates the nature of the trade-off between risk and returns for the farmers in the study area.

Chapter VII analyses farmers subjective perception of risk, and determines risk preferences for farmers based on the assumed model. The preferences are then related to the socio-economic characteristics of the farmers in order to ascertain a possible relation.

Chapter VIII provides a summary of the result and findings of the study. The policy implications for future planning and enterprise combination in the study area are discussed. Finally suggestions for further research beyond the scope of this study are given.

CHAPTER II

LITERATURE REVIEW ON RISK ANALYSIS AND DECISION MAKING

This chapter reviews literature on both theoretical and empirical developments in Risk Analysis. Sections 2.1 to 2.3 focus on developments in the theoretical concepts on Risk Analysis while sections 2.4 to 2.6 reviews practical application of the various decision theories.

2.1 Approaches to Behavioural Decision Analysis

Three approaches in Behavioural Decision theory are relevant to the understanding of the theoretical basis for this study and are highlighted below in order of historical development

2.1.1 Direct Elicitation of Utility Functions

The foundation of the expected utility theorem goes back to Daniel Bernoulli who as early as 1738 suggested that the optimal behaviour of the decision maker is that which maximizes expected utility. Bernoulli assumed that utility is cardinally measurable and that the decision maker should maximize his expected utility. Typically, the Bernoullian decision theory is defined by Dillon, 1971, as follows:

> "Bernoullian decision theory is a normative approach to risky choice based upon the decision maker's personal strength of belief (or subjective probabilities) about the occurrence of uncertain events and personal valuation (or utility) of potential consequences (p.4)".

Following this definition, the expected utility model provides a single-valued index which orders action choices according to the preferences or attitudes of the decision maker. In 1944, Von Neuman and Morgenstern demonstrated that the utility concept follows logically a set of assumptions or axioms about individual behaviour. The set of axioms is summarized as follows:

(i) Ordering of choices: For any two action choices, A_1 and A_2, the decision maker either prefers A_1 to A_2, prefers A_2 to A_1, or is indifferent between them.

(ii) Transitivity among choices: If A_1 is preferred to A_2, and A_2 is preferred to A_3, then A_1 must be preferred to A_3.

(iii) Substitution among choices: If A_1 is preferred to A_2, and A_3 is some other choice, then a risky choice $pA_1 + (1-p)A_3$ is preferred to another risky choice $PA_2 + (1-p)A_3$, where p is the probability of occurrence.

(iv) Certainty equivalent among choices: If A_1 is preferred to A_2, and A_2 is preferred to A_3, then some probability p exists that the decision maker is indifferent to having A_3 with probability (1-p). Thus A_2 is the certainty equivalent of $pA_1 + (1-p)A_3$.

According to Bernoulli's principle, if a decision maker obeys these axioms, there exists a utility function U(A) which reflects the decision maker's preference among different alternative outcomes. If the alternative outcomes represent different levels of income Z, then the result is a utility function of income U(Z). When enough utility values are available from repeated gambling questions, a utility index or function can be fitted to these values using graphical or statistical procedures. Graphically, a farmer's attitude to risk is inferred from the shape of his utility function. As presented in Figure 2.1, a function concave to the origin implies risk aversion, a linear utility function implies risk neutrality, and a convex function implies a risk preferring attitude. A decision maker may also have a utility function with both concave and convex segments indicating changes in risk attitudes for different monetary outcomes.

An important characteristic of the utility functions is that they are monotonically increasing, i.e., if $Z_1 > Z_2$ implies $U(Z_1) > U(Z_2)$. The implication of increasing monotonicity is the neoclassical axiom that more income is preferred to less, i.e. $\delta u/\delta z > 0$. Although the first derivative of the utility function is positive, the second derivative may be negative ($\delta^2U/\delta Z^2 < 0$), zero ($\delta^2U/\delta Z^2 = 0$), or positive ($\delta^2U/\delta Z^2 > 0$) which implies that the marginal utility of extra income is decreasing, constant or increasing. As shown in Figure 2.1, farmers with such utility functions are characterized as risk averse, risk neutral or risk preferring, respectively.

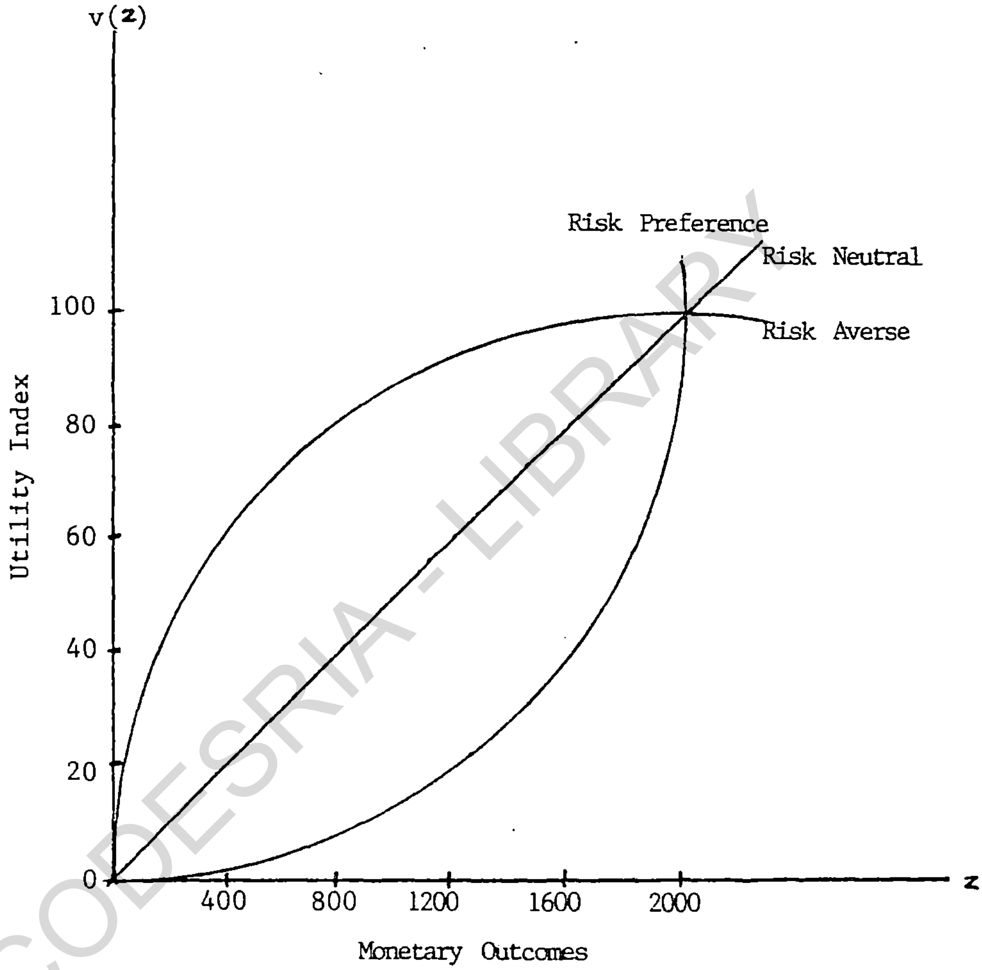


Figure 2.1 Graphical Estimation of Risk Attitude Represented by Three Utility Functions

Despite the fact that the Bernoullian Principle implies the existence of U(Z), it tells nothing of its precise form, nor does the decision maker intuitively know the algebraic form of his utility function. Dillon, 1971, argued that a variety of different functional forms may suit, such as polynomial, logarithmic or exponential utility functions. However, he recommended using the functions that provide simplest manipulation.

Direct elicitation of the utility function has been emphasized in a series of studies (Officer and Halter, 1968; Lin, Dean and Moore, 1974; Halter and Mason, 1978; Dillon and Scandizzo, 1978; Hildreth and Knowles, 1982). This approach, however, has been criticized as subject to bias from different interviewers, preference for specific probabilities, negative preference towards gambling, absence of realism in the game setting, lack of time and experience of the participants to become familiar with the hypothetical choices, and compounding of errors in the elicitation process (Roumasset, 1978). Furthermore, studies by Binswanger, 1980, Dillon and Scandizzo, 1978, have indicated that eliciting individual farmer's utility functions are expensive, time consuming, and may not be stable over time because they vary with the socioeconomic status of the household. Hazell, 1982, stated.

> "It seems unlikely that direct elicitation will ever be a widely adopted approach in farm advisory work. A more practical approach has proved to be the derivation of a number of farm plans in the efficient E-V set, and to present these to the farmer for his choice (p.386)".

The E-V approach was therefore proposed as relevant to decision making by the small farmers.

2.1.2 Mean-Variance Efficiency Criteria

Both quadratic and linear risk programming provide paths to estimate the expected return-variance (E-V) efficiency frontier. The approach is widely used in whole farm planning models incorporating risk. It is based on the following assumptions:

(i) the farm decision maker views the outcome of any production activity in probabilistic terms meaning that net return or gross margin is considered to have a probability distribution which is normally distributed (Anderson, et al., 1977);

(ii) in assessing the desirability of alternative combination of farm activities, the decision maker holds preference among farm plans solely on the basis of their expected income E and variance of expected income V. Therefore his preference can be represented by the following utility function:

$$U = U(E,V) \qquad \ldots\ldots\ldots \qquad (2.1)$$

The utility indifference curves derived from Equation 2.1 are assumed to be convex with positive slopes. This means that farmers are risk averters, i.e. increasing level of expected income are necessary to offset higher levels of risk bearing.

Other assumptions required to ensure that the iso-utility curves for the farm firm decision maker exhibit the convexity property are: (a) higher expected incomes are preferred to lower incomes, ceteris paribus; (b) a low variance is preferred to a high variance for a given level of expected income; and (c) there is a diminishing marginal rate of substitution between the expected level and variance of income. The first two assumptions guarantee the positive slope of the iso-utility curves and the third assumption implies that the iso-utility curves will be convex as depicted in Figure 2.2. In terms of calculus the relationships in Figure 2.2 can be stated as follows:

1. $\delta U/\delta V < 0$ i.e., the expected utility will decrease with an increase in risk.
2. $\delta U/\delta E > 0$ i.e., the expected utility increases with an increase in expected income.
3. $\delta E/\delta V > 0$ i.e., the farmer would prefer a farm plan with higher variance (V) if, and only if, expected income (E) was also higher.
4. $\delta^2 E/\delta V^2 > 0$ i.e., the compensation in (3) would have to increase at an increasing rate with increases in risk.

Further discussion on the above relationships is presented by Sharp, 1963, Johnson, 196, and Hazell, 1971).

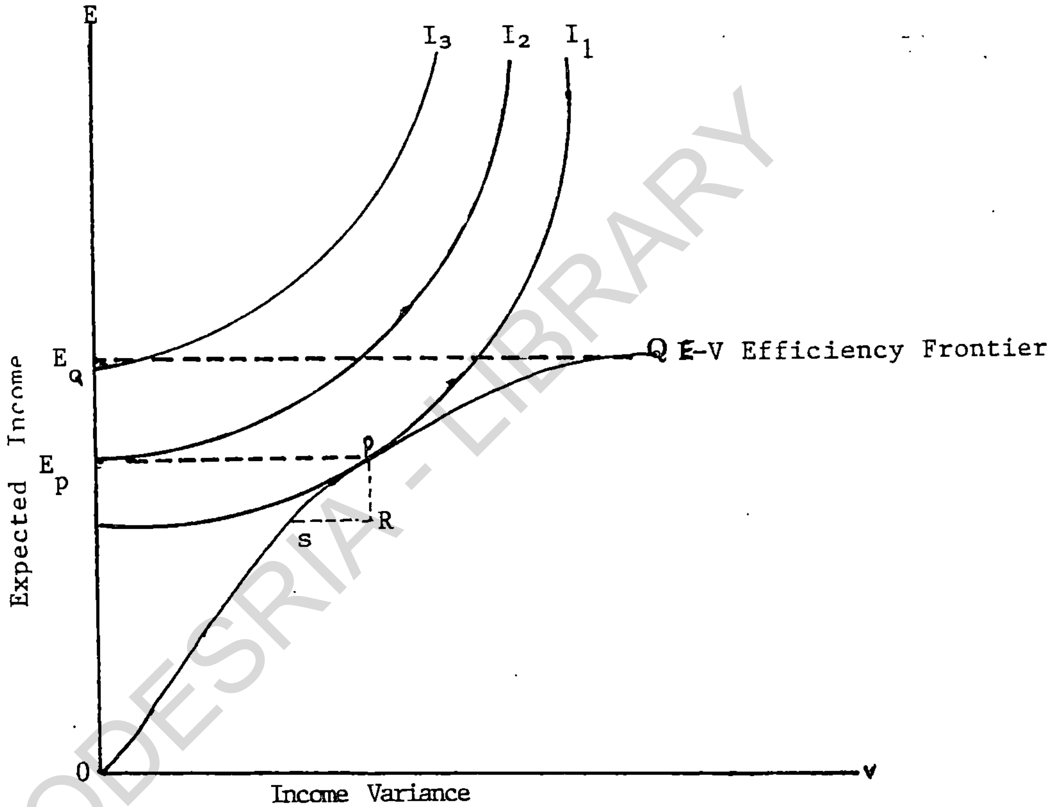


Fig. 2.2: The E-V Efficiency Frontier and Optimum Farm Plan

As shown in Figure 2.2, the upper bound 0Q of the feasible set is the efficiency frontier. The feasible set is bound above since net revenues from production activities have finite means and variances. Each point lying on the upper bound 0Q corresponds to the highest level of expected income attainable for each level of income variance.

From the behavioral assumptions concerning the iso-utility curves, one can conclude that only farm plans having means and variances which lie on the efficiency frontier are expected to be potential choices for the decision maker. Every alternative plan whose expected income and variance is given by a point interior to 0Q is dominated by an alternative which has the same variance but a higher expected income or the same expected income and a lower variance. For example, in Figure 2.2, point R is dominated by point P and point S. Point R has the same variance as point P, however, point P has greater expected income. Similarly, point R has the same expected income as S but S has lower variance than R. It follows that the E-V efficiency frontier can be defined as the locus of all efficient farm plans encountered with the lowest variance for any given income or the highest income for any given variance. Point Q on the efficiency frontier represents the result from the deterministic expected profit maximizing solution where the decision maker is assumed to be risk neutral. A rational farmer who is averse to risk and his utility preference corresponds to the utility function, I_1 shown on Figure 2.2, would select the farm plan represented by point P along the efficiency frontier.

Despite its wide applicability and acceptability as a planning tool for farmers under risk, the E-V efficiency criteria is associated with some problems. The decision maker is assumed to be everywhere risk averse. When this assumption does not hold, the preferred choice may be excluded from the E-V efficient set. Thus most empirical researches prefer approaches that generate solutions that meet the test of second degree stochastic dominance. These are mostly now in the area of probability of loss function.

2.1.3 Probability of Loss Function

A definition of risk that is widely applied in the literature, explains risk as a "chance of loss" or the probability (α) that net income (π) will fall below some critical or disaster income level (d). Mathematically the definition can be expressed as:

$$\Pr(\pi < d) = \alpha \qquad \text{........} \qquad (2.2)$$

This definition relates to the "safety-first" models developed by Roy, 1952, Telser, 1956, Baumol, 1963, and Pyle and Turnovsky, 1970). It specifies that a decision maker first satisfies a preference for "safety" in organizing a firm's activities, and then follows a profit oriented course of action. The following discussion represents a probability of loss function criterion proposed by Baumol.

Baumol, 1963 criticized the E-V approach on the ground that many alternative farm plans along the efficiency frontier may be confusing to the decision-maker. In addition, plans which do not provide a high probability of meeting minimum level of income are likely to be rejected by farm decision-makers. For example, assume a farmer's minimum acceptable level of income is N1,000. Therefore only farm plans which generate this income level, at a reasonably high level of probability, are considered in the probability of loss analysis.

Baumol's criticism was based on expected gain confidence limits for portfolio selection. The model can be defined as a set of confidence statements about achieving various levels of income. The income from every efficient plan is assumed to be normally distributed with mean E and variance V. The basic assumption is that the rational decision maker can base his choice for a particular plan on the expected income and the minimum acceptable level of income which could be obtained from that plan, with a given degree of probability. To compute the critical income level d*, for every level of expected income E, we can use the following equation:

Max E .... (2.3)

Subject to: $E - K_{\alpha}S \geq d$ .... (2.4)

where

d = is the critical level of income;

E = is the level of expected income;

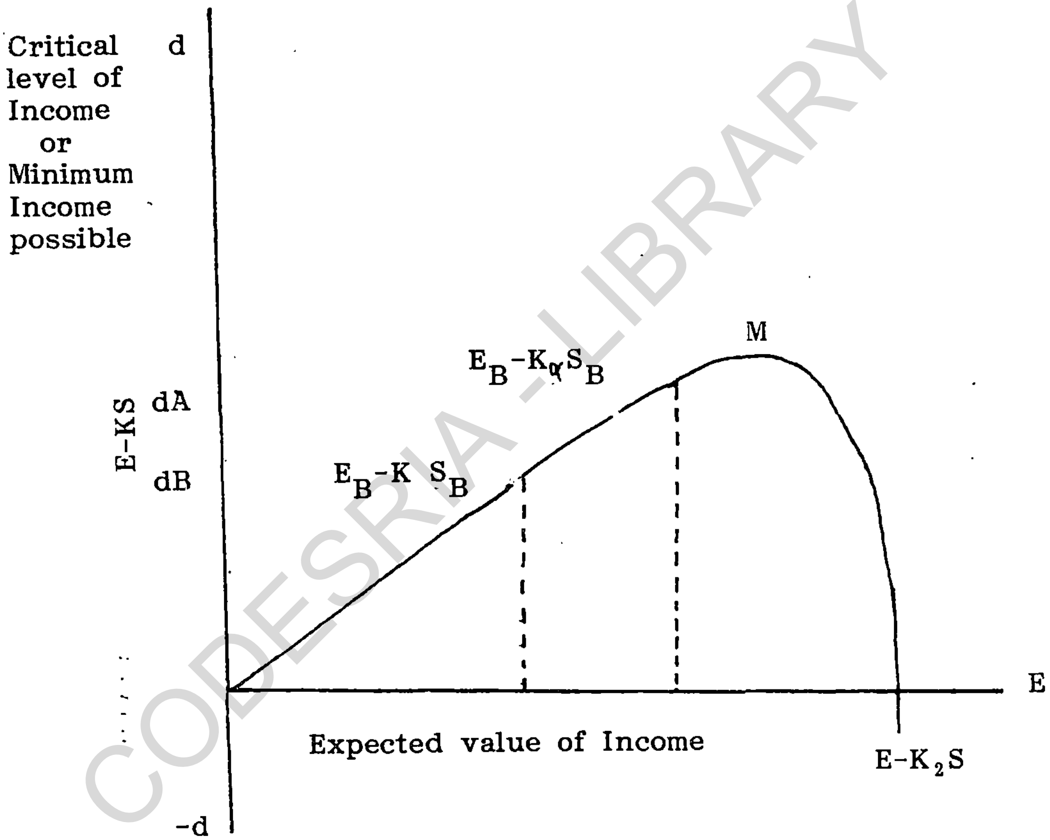
S = is the standard deviation of income; and

K = is a factor from the standard normal density function taken at the desired probability level.

The criterion is described in Figure 2.3. The expected value of income E of various efficient plans is presented on the horizontal axis. The vertical axis represents the values of $E-K_{\alpha}S$ corresponding to the same plans. Although all farm plans obtained with the E-V analysis are efficient, it can be demonstrated that the decision maker may readily reject some of them. For example, he will generally prefer farm plan A to farm plan B because $E_A > E_B$ and $(E_A - K\alpha\ S_A) > (E_B - K\alpha\ S_B)$. That is, farm plan A offers both a higher expected income (E) and a higher floor of income (d). However, a rational decision maker would have to choose the farm plan corresponding to point M since at M he can achieve a higher expected income and more safety (higher d) at the same probability level. In addition to making this single-valued suggestion, presenting bands for different probability levels would allow the decision maker to have a wide choice and hence a satisfactory level of enterprise combination which maximizes expected income subject to a minimum critical level of income.

2.2 Measures of Risk, Risk Preferences and the Economic Environment

It is important to recognise that risk behaviour depends



E = Expected Income
S = Standard deviation of Income
K = Factor From standard normal density function

Figure 2.3 Probability of Loss Function Associated with Certain Probability Level.

not only on individual preference but also on the economic environment in which the choice is made. If there is a complete set of risk markets available, even a strongly risk averse person may make choices which appear to be risk neutral. On the other hand, imperfect market may lead to apparently risk averse behaviour by risk neutral individual. In practice, the economic environment will contain a range of imperfect risk and capital markets which will affect observed risk behaviour. Thus estimates of risk characteristics will be a function of personal characteristics and of the environment. One of the weaknesses of attitudinal and experimental studies of risk behaviour is the ambiguity about economic environment in which the choice is made. Econometric studies measure apparent risk attitudes as they are expressed in the individuals normal environment. This is probably the most realistic approach and the one which is most relevant to policy needs. Thus, this approach is adopted for this study.

The concept of risk in any application depends on the behavioural decision model employed. The popular Bernoullian, 1953, expected utility criterion utilizes an objective function that is a function of all the statistical properties of the outcome of risky actions $a_i (i = 1 .....n)$ available to the decision maker. In practice, it is popular among empiricists to assume that the underlying utility function is quadratic and that profits are normally distributed yielding the simpler function of mean and variance only (Young 1979).

Thus

$$\text{Max}_i \text{ (EU) of } a_i = f(\mu a_i, \sigma^2 a_i) \quad .... \quad (2.5)$$

With this equation (2.5), variance or standard deviation or coefficient of variation is clearly the appropriate 'measure of risk".

Different sets of risk concepts are implied by various non-Bernoullian decision models. For example, the <u>"minimax"</u> model would identify the maximum loss of an action, (regardless of how remote the probability of its occurrence) as a measure of riskiness of an action. The <u>lexicographic</u> "safety first" model identifies the probability (α) that random profit (π) will fall below some critical or "disaster" level (d) as risk, i.e

$$P_r (\pi < d) = \alpha \quad .... \quad (2.6)$$

Most formal definitions of risk rely on the Bernoullian conclusion that risk preference can be encoded in a utility function for money (income or wealth) and the associated expected utility function as in equation (2.5) above. Positive Marginal Utility (MU) of income (i.e. $U'M > 0$) is usually assumed for the utility function. With the framework of Bernoullian decision theory, the following measures of risk yield equivalent risk preference classification (Young, 1979):

(i) $U''M$

(ii) $-U''M/U'(M)$

(iii) $\delta EU/\delta\sigma^2$

(iv) $(\delta M/\delta\sigma^2)$ $\quad EU = \text{constant}$

(v) Risk Premium.

A decision maker is classified as risk averse, risk neutral or risk preferring respectively as measures (i) or (iii) is less than, equal to or greater than zero.

For measures (ii), (iv) and (v), the inequalities are reversed to indicate the respective classifications. A Bernoullian utility function is unique only up to a positive linear transformation. In recognition of this property, Pratt developed $(-U''M/U'(M))$ as a unique measure of absolute risk aversion. Measure (iii) directly measures the impact of a change in risk (σ) on expected utility. Measure (iv)

ABSTRACT

The study examines the extent to which incorporation of attitudes towards risk in farm planning helps farmers to plan for crop production; and policy makers, to appreciate farmers' response to policy decisions. It provides some quantitative information on risk attitudes of farmers under "the safety-first principle" and Expected Income - Absolute Deviation (E-A) criterion. The relation between measured risk coefficients and socio-economic characteristics of the farmers was also examined.

Both primary and secondary data were utilized for the study. The primary data were collected from the farming population in three strategically located Agricultural Development Project areas in Nigeria: The Bauchi ADP Which covers part of middle belt and the Northern Agricultural zone, the Oyo ADP, located in the Western zone and the Imo ADP in the Eastern Agricultural zone of the country. The secondary data were obtained from the past records of Agricultural Development Projects, past studies in the project areas, publications of the Federal Office of Statistics and Federal Ministry of Budget and Planning Lagos (now National Planning Commission).

The analytical approaches adopted for the study were the Target-Minimization of Total Absolute Deviation (T-MOTAD) and multiple Regression technique. The Target-MOTAD model was constructed to get data to elicit risk coefficients for the farmers and to analyse the expected return-risk trade-off for the farmers subject to a targetted minimum level of income. Also a simple analytical method through ranking was used to elicit farmers' subjective judgement of risk in crop production.

Sole cowpea enterprise was identified as the most risky enterprise while planting mixed crops lowers risk considerably. It was shown that by increasing Credit and by optimizing and including better crops, farmers can increase the net return than they are presently taking. Risk level of farm plans increases as expected return increases.

Five socio-economic variables were identified to be particularly significant in influencing the farmers risk behavior. Age and family size have negative impact on risk while farm income, off farm income and loan procurement have positive influence on risk taking disposition of the farmers. These variables are all significant at five (5) percent level of significance.

The study concluded that the problem of the small scale farmers is not their inability to take risk but the lack of information about opportunities available for making necessary decisions under uncertainty. The study recommended, among other things, improvement of extension services, an extension of crop insurance scheme to cover all crops, introduction of new varieties of seeds, and continuous use of fertilizers and insecticides to offer the farmers a better base to hedge against risk.

attributable to Marra, represents the Marginal Rate of Substitution (MRS) between risk and income.

An intuitively attractive measure of the degree of risk aversion is the amount an individual will willingly pay to avoid participation in a fair bet or the risk premium. More generally, the risk premium for a risky action is the difference between its expected monetary value and its certainty equivalent. The certainty equivalent of a risky action is the certain outcome that yields an identical level of satisfaction. It should be recalled that, regardless of how measured, risk aversion is a local characteristics; that is, its sign and degree can vary depending upon the stakes involved.

2.3 The Principle of Safety First and Limited Knowledge

This study utilized a Target-MOTAD model under safety-first principle which was proposed by Roy in 1952 and modified by several researchers thereafter. His objection to received economic theory was that it was set against a background of ease and safety. He noted that to dispel this artificial sense of security, theory should take account of the often close resemblance between economic life and navigation in poorly charted water. Decision taken in practice are less concerned with whether a little more of this or that will yield the largest net increase in satisfaction than in avoiding known rocks of uncertain position so that should a rock turns up, total disaster is avoided (Roy, 1952).

In an economic world, disasters may occur if an individual makes a net loss as a result of some activity or if his resources are eroded by the process of inflation. For a large number of people, some such idea of a disaster exists and the principle of safety first asserts that it is reasonable and probable in practice that an individual will seek to reduce as much as possible, the chance of such a catastrophe occurring.

This approach in risk programming relies on transforming the stochastic objective function into a non-stochastic one, specified in terms of expected income of each activity. The maximizing behaviour is then constrained by some specification of the probability of not attaining some critical low level of income. The farmer's response to risk and uncertainties is then a function of this probability of loss and his notion of a minimum level of subsistence which as it turns out are important parameters when put in a planning context. This concept was developed by Roy and termed "Safety-First". There are various modifications and alternative specifications of this safety first constraint as given by Telser, 1962, Kataoka, 1963, and Boussard and Petit, 1967. The present study employs a linear formulation of safety-rules developed by Hazzel, 1971 modified and already given applications by Kennedy and Francisco, 1974, Brink and McCarl, 1978, Mruthyunjaya, and Sirohi, 1979, Anderson and Hamal, 1983, Tauer, 1983, Crawford, 1986, Berbel, 1988. This formulation is a linear programming model called Target-MOTAD (Minimization of Total Absolute Deviation) programming as developed by Tauer, 1983). This is the most recent widely accepted Risk Programming Methodology. (Berbel, 1990).

In risk situation, the individual farmer is assumed to be averse to risk so that his objective function is defined by the dual criteria of maximizing net returns and minimizing the variance of net returns. Thus the net returns absolute deviations are minimized subject to expected total net return levels and other resource constraints. In Target-MOTAD, the expected returns is maximized with a constraint of net returns not falling below a critical target level.

2.3.1 Specifications of Safety First

The safety first improves on other models of indexing action choices, such as Maximax, Minimax, Maximin etc., by focusing an outcome or income (Y_d) which may be different than either the most favourable or worst possible outcome of each action choice (Roumasset, 1978). This Y_d is often referred tc as the safety or disaster level of income below which a firm fails to meet its cash obligation or becomes bankrupt. In a developing country context, the disaster level is interpreted as the minimum level of production yield, or returns needed to meet subsistence requirement. The model therefore, assumed that the decision maker's primary goal is to select action choices so as to minimize the chances of experiencing outcomes at or below the disaster level (Y_d).

Roy suggested that investors have in mind some disaster level of returns (Y_d) and that they behave so as to minimize the probability (p) of returns (Y_1) falling below that level. Later, safety first models proposed by Telser and Kataoka incorporated a recognition of the objective of maximizing returns or income subject to the constraint of minimizing the chances of receiving returns less than (Y_d).

The 3 alternative specifications are:

(1) Minimize $P(Y_i \leq Y_d) \leq \alpha$ (Roy)

(2) Maximize $E(a_i)$ subject to $P(Y_i \leq Y_d) \leq \alpha$ (Telsar)

(3) Maximize Y subject to $P(Y_i \leq Y_d) \leq \alpha$ (Kataoka)

where Y_i = level of returns;

$E(a_i)$ = expected profit of i_{th} action

Y_d = disaster level;

α = probability of disaster.

The general concept of safety first can be illustrated with figure 2.4 which shows a cumulative density function of the outcome of two action choices, a_i and a_j. A cumulative density function for each action choice can be obtained by summing its probability density function. Point B on the cumulative density function $G_j(y)$ can be interpreted as the probability of outcome equal to or less than yb, j. The maximum value $G_j(y)$ can take on is one, which is the sum of all probabilities of yk, i occurring.

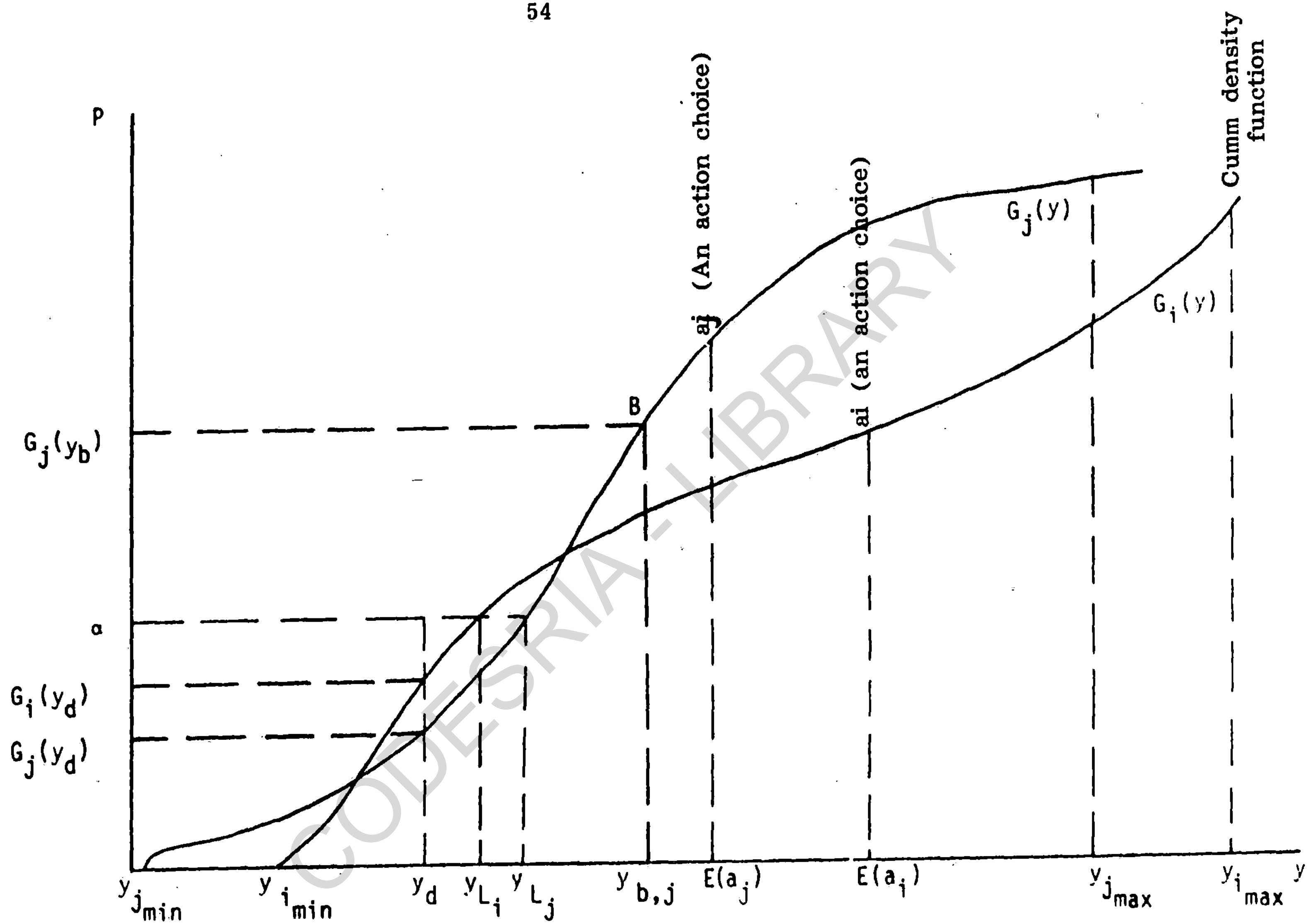


Figure 2.4 Cumulative Density Functions $G_i(y)$ and $G_j(y)$ Describing Probabilistic Outcomes of Receiving y or Something Less

If the decision makers acted in accordance with the safety first model proposed by Roy when faced with the cumulative density function presented in figure 2.4, they would prefer the action choice a_j represented by $G_j(y)$. At the disaster outcome level y^d, $G_i(y_d)$ is greater than $G_j(y_d)$ indicating that the probability of y_d or something worse occurring is greater with the i^{th} action choice than with the j^{th} action choice. Thus action choice a_j would be preferred even though it has a lower maximum possible outcome (ymax, j < ymax, i) and a worse minimum outcome (ymin, j < ymin, i).

If a decision maker faced with the same decision problem was using the criteria proposed by Telsar, however, he would prefer action choice a_i over action choice a_j. Under Telsar's restrictions, the decision maker attempts to maximize expected returns E (ak) k = i ...., n), subject to the constraint that the probability of return less than the disaster outcome Y_d does not exceed a given probability. Both the cumulative density functions in figure 2.4 show that probability of y_d or less occurring is less than α for their respective action choices. Since this constraint is satisfied, the decision maker will base his choice on expected return which are greater for action choice a_i than for action choice $a_j (E(a_j) < E(a_i)$.

If he follows Kataoka's safety first rule, the decision maker would again prefer action choice a_j. This rule is based on a particular probability value of $G(y_1)$ indicated by α. The decision maker will prefer the action choice with the largest value of yl at a given value of G(yl) (e.g. α). In figure 2.4, $G_j(y)$ is preferred to $G_i(y)$ since the value of yl, j is greater than yl, i.

One thing that should be noted about all the safety first models is that they focus on only one level of outcome or one level of probability of outcomes.

2.4 Empirical Approaches to Risk Measurements

In the absence of an accepted body of theory of decision making under risk, several approaches have been used to explain farmers behaviour under situation of risk (Webster, 1978). The approaches are based on different assumptions made about:

(i) the available information on gains and losses under given various alternatives;

(ii) value given to various gains and losses; and

(iii) the way in which the arbitrage between the risk taken and the expected gain is made.

Studies on risk have therefore, implied that there is a known probability distribution of gain and that the best strategy is that which maximizes some function which depends upon the gains and moments of probability distribution. The approaches to risk measurement can be classified under the Direct and Indirect approach.

The direct approach usually called direct elicitation of utility function (DEU) was proposed by Von-Neumann in 1944 through sets of behavioural axioms which were subsequently developed by Arrow, 1951, and Pratt, 1964. These axioms demonstrated that an individual's preference between 2 or more outcomes of a risky prospect can be determined provided we know the distributional properties of the risky prospects and the curvature properties of the individual utility function. In this direct method, the individual is asked to make decision in reaction to a large number of randomly arranged hypothetical bets and insurance schemes. Utility functions are then derived through interview procedures designed to determine points of indifference between certain outcomes and risky options involving hypothetical gains and losses. After series of points in the U-M space have been identified in the interview, an explicit utility curve can be fitted to the point by regression analysis.

The DEU technique has been critized as subject to bias arising from different interviewers, preference for specific probabilities (e.g. a 50:50 bet), confounding from extraneous variables and negative preferences toward gambling (Roumasset, 1979), Binswanger, 1980). Choice of an inappropriate functional form for the utility function can lead to undesirable implications (Lin and Chang 1978). Also utility associated with the outcome of a particular risky action is probably dependent upon more variables than monetary gains and losses alone. Inability to hold these other variables constant while eliciting single attribute utility functions is likely to lead to substantial impression. According to Young, 1979, even if the above "technical sources of bias" could be removed by refined interviewing and econometric techniques, the representativeness of choice involving hypothetical gain and losses in a parlor game setting could be questioned. Does a utility function elicited in a short interview around a farmer's living room table reflect his attitudes toward risk in real world decision? In the later case, he has much more time to consider a decision, can and often does solicit advice from family members and friends and is fully aware that he must live with the consequences of his decision.

Although the preceding remarks indicate sources of considerable apriori concerns, ultimate judgements on the validity of direct elicitation of utility (DEU) approach should consider its ability to produce results that are in accord with observed economic behaviour. The unique comparative study of Lin, Dean and Moore, 1974 evaluated Bernoullian utility, lexicographic utility and expected profit maximization models. The authors concluded that although the expected profit model was the poorest predictor, "none of the models predicted actual behaviour well with a strong tendency for all models to predict more risky behaviour than was in fact observed".

Furthermore, the DEU approach had serious difficulties resulting from the fact that the subjects have different degrees of utility or disutility for gambling (Edwards, 1961) and the method is time consuming (Lin, et al, 1974). As a result, the measurement of risk thus obtained have been few (Bond and Wonder, 1980), (Smith and Desvourages, 1988) and attempts at relating these measurements to explanatory variables have been unsuccessful (Halter and Beringer, 1960). Officer and Halter, 1968) or only partially successful (Scandizzo and Dillon, 1976, Anderson and Hamal, 1983).

The technical difficulties of the Direct Elicitation method led to the proposition of a variant of the direct method called experimental method by Binswanger in 1978. Binswanger, 1978 reported an "experimental method" drawing on Psychological research for measuring risk preferences of more than 350 peasants in Rural India. This approach which involved the use of actual financial compensation at significant level, was conducted in a series of several visits over five or more weeks which permitted the respondent ample time to reflect on each decision and discuss it with others if desired, and required only a simple choice among 8 gambles which outcomes were determined by a flip of a coin. Impressive efforts were made to teach respondents the nature of the game, to elicit responses reflecting true feelings, to avoid interview bias and to eliminate other sources of error.

Binswanger developed this experimental approach after rejecting the DEU interview method. His field checks on the interview method led him to conclude "that evidence on risk aversion from pure interviews is unreliable, non-replicable and misleading, even if one is interested only in the distribution of risk aversion rather than reliable individual measurement".

The realistic experimental approach utilized by Binswanger goes far in remedying some of the more serious measurement flaws of the DEU method. It is obvious however that such games could not be funded for realistic levels of gains associated with major farm decisions in many countries. Binswanger spent approximately $2500 for price money in this India Experiment. He estimated a comparable experiment in the United States would require $150,000 for prices alone.

Since Binswanger Indian risk aversion experiments, at least three other researchers have applied Binswanger's general experimental method in other less developed farming communities. Sillers, 1980 compared the choice behaviour of 2 matched samples of rice farmers in central Luzon in the

Philippines, one group faced risks involving only gains, while the other group faced risks involving both gains and losses. These experiments also used unequal probability games to assess the impact of probability preference on choice. Walker, 1981 measured risk preferences among maize farmers in Northern Elsavador and used the result to investigate the adoption of hybrid varieties. Grisley, 1987 also used a large number of risky alternatives to give a more precise estimate of individual risk preferences and made several methodological refinements in his study of rice farmers in Northern Thailand. Finally, Belad and Miller, 1987, used a modified experimental approach to elicit farmers utility function in eastern high Plateau of Algeria and test hypothesis that farmers risk attitudes were modified by the agroecological zone in which they live.

In an attempt to make direct method suitable, most researchers have also used the interval approach, a method which relies heavily on the principle of stochastic dominance proposed by Meyer (King and Robinson, 1981, Tacier, 1984). This method requires the selection of one or two risky prospects rather than a sure thing and a risky prospect, and so is not subject to aversion to gambling. However, it is also subject to hypothetical income situation and interviewers bias.

The doubt surrounding the validity of directly elicited utility (DEU) functions have encouraged researchers to seek indirect measures of risk preference. Studies of this nature have either focussed on input utilization or output supply of individual farmer. This approach compares observed economic behaviour (OEB) with respect to factor demand and output supply to behaviour predicted by theoretical model incorporating risk and risk preferences. Pope (1976) has proposed an econometric approach based on the OEB concept, that provides estimates of an assumed constant risk aversion coefficient under certain assumptions. Moscardi and de Janvry, 1977, have also utilized this OEB approach within a safety first framework.

On the supply side, Brink and McCarl, 1978, derived indirect estimates of risk aversion coefficients of 38 large corn belt farmers by comparing their elicited cropping plans to those predicted by a variant of Hazzel's MOTAD model. The value of the parametrically varied risk aversion coefficients that minimize the difference between the model's predicted plan and the farmers actual plan was selected to represent the farmers risk preference. Other users of this approach are Schurle and Erven, 1988, Mruthyunjaya and Sirohi, 1979, Mara and Carlson, 1990.

These indirect approaches as applied in literature have used different parameters of distribution of outcomes to measure attitudes toward risk and riskness of a decision. Among others, analysts have used the variance (McFaqual, 1961), semi-variance, absolute deviation (Hazzel, 1971, and minimum level (McLnerney, 1969, for such a measure. Often the results are specified as risk aversion parameters and efficient set of plans from which the decision maker is expected to choose (Hazzel and How, 1970). But, the statement of the problem demands a powerful tool such as quadratic programming which requires many data set, variances and covariances which are not generally available at the farm level.

The theory of games from which a number of criteria were developed (Agrawal and Heady, 1968) was also criticized because of the lack of generality (Dillon, 1962, Scott and

Baker, 1972). An area which has proved "fertile" in literature on risk is the safety-first concept which regards choice as being dependent upon, for instance, the expected value of a variable, a disaster level of that variable and the probability of that disaster level (Kennedy and Francisco, 1974). There has been a number of formulations of this safety rule but choice is usually made by maximising (or minimizing) one of these measures subject to constraints on the others.

Moscardi, 1977, examined attitudes toward risk among peasants in Mexico in a model of safety first behaviour. The measurements of behaviour obtained were then explained by a set of socio-economic and structural variables that characterised the peasant household. Using econometric approach, he showed risk aversion to be responsible for substantial differences between optimum and actual allocation of fertilizer in crop production. Risk premium were very high thus discouraging the use of high rates of fertilizer under safety first behaviour. Shackle's concept of "focus-loss" was also a linear formulation of safety first concept and has been given application in farm planning by Boussard and Petit, 1967 and Kennedy and Franscisco, 1974. An attempt has also been made to quantify the trade-off between focus loss and expected income and sets of indifference curve derived from this indirect approach was compared to farmers utility function from Von-N and Morgestein direct method.

The indirect method was found more suitable for representing farmers attitude and behaviour under risk because in all these studies, predictive farm plan was found to be compatible with farmers' plan. Another variant of the safety-first concept is the minimization of total absolute deviation (MOTAD) introduced by Hazzel, 1971. It involved the dual criteria of maximizing net return and minimizing the variance of net returns. A number of applications to farmers situation have been made by Kennedy and Francisco, 1974, Mruthyunjaya and Sirohi, 1979, Singh and Kamal, 1983. The MOTAD model was also modified by Tauer in 1983 through his target-MOTAD model approach. He demonstrated that all solutions generated with a target-MOTAD model belong to the second degree stochastic dominance efficient sets. Stochastic dominance techniques are appealing as their application requires very few restrictive assumptions about the decision maker's utility function. Watts, Held and Helmers, (1984) compare MOTAD and target MOTAD and argued that target-MOTAD was better than MOTAD. McCamley and Kieberstain, 1986, Marra and Carlson, 1987, Puharzhendhi, 1987, Berbel, 1988 and Berbel, 1990 Chavas and Holt 1990 Pannel, 1990, Foster and Rauser, 1991 have given applications to this modified approach.

These indirect approaches of risk attitude measurement through observed economic behaviour (OEB) of farmers shares with the direct method, (DEU) the advantage of furnishing measures that can be incorporated directly into models of economic decision making. In addition, it escapes the compelling criticisms that the revealed risk preference may not be true to real world decision.

Under safety first concept adopted for this study, it is necessary to assess farmer's trade-off between output or income and his needs for security. First, either a dual - valued objective function or a risk-constrained objective function must be chosen to capture the farmer's response to uncertainty in his production environment. In either case, some apriori assumptions must be made about the farmer's risk preferences; it is generally assumed that the farmer is a risk averter. Technically, risk aversion is related to the curvature of utility of income function with increased concavity of the utility function implying greater aversion to risk. It is widely believed (and available evidence provides support for this view as in Young, 1979, Binswanger, 1981, Kireta-katewu, 1985, and Antle, 1987, that most individuals are averse to risk when they are faced with significant economic choices although they may be risk preferring when it comes to recreational gambling.

Much of the literature on farm innovations in small holder agriculture had shown farmers' to be risk aversed. For example Wiens, 1976, in a quadratic programming model of chinese peasants agriculture showed that farmers allocated their resources as if they were risk aversed and derived acoefficient of risk preference which was negative, thereby providing evidence for risk aversion.

This evidence was supported by Dillon and Scandizzo, 1978, who measured how small farmers in the semi-arid areas of North-east Brazil responded to risk under conditions where (1) their subsistence was guaranteed and (2) their subsistence was at risk. They also measured coefficients of risk aversion but across a sample thereby ascertaining properties of the distribution of the coefficient. They concluded that no owner and only a minimum number of share croppers displayed any risk preference when subsistence was at risk while a significant number of subjects of both categories appeared to be eager to take risk (under conditions where subsistence was assured). This is an important result that indicated furthermore that small farmers are likely to follow safety-first criteria when satisfaction of basic needs may be at risk. This latter study also provides empirical support for the assumption of farmer's risk aversion and his risk evaluation according to safety-first principles. Also in Nigeria, Walker and Jodha, (1982) in their study on how farm households adapt to risk concluded that farmers generally are risk averters. Evidences of farmers risk aversion also emanated from studies of Olayide, 1968, Norman, 1972, Uwakar, 1980, and Morris, 1981.

Finally, in Sierra Leone, Jonny, 1981, discovered that upland rice farmers preferred lower but less variable yielding rice variety. From his analysis, he attributed this preference to farmer's concern with certainty and security of subsistence and their aversion to risk.

2.5 Selective Applications of Risk Programming Models

The Schultzian notion that in traditional agriculture, farms maximize profits and therefore use resources efficiently within limits of traditional technology has been subject to criticism. Lipton, 1968, argued that farmers may choose less risky crops even if they are less profitable. According to this interpretation, if we assume that farmers are utility maximizers, allowance must be made for some trade-off between variance (as a measure of risk) and expected profit. Such allowance cannot be made under the assumption that farmers are profit maximizers. Moreover, the variability of production from year to year implies that economic efficiency is equivalent to maximizing the expected income over some time period.

Consequently, a farmer may choose a lower expected income associated with less variability of income to ensure a higher probability of "staying in business". Furthermore, Lipton, 1980, argued that farmers do not maximize profits as high profit levels are associated with too much risk. A similar conclusion is reached by Dillon and Anderson, 1971 which led them to state the following hypothesis:

"We would hypothesize that farmers in traditional agriculture (and elsewhere) typically have non-linear utility functions (implying active consideration of subjective risk) and successfully endeavor to maximize expected utility rather than expected profit.... in our view, quantitative information on risk attitudes must be an important element in understanding farmer behaviour in underdeveloped agriculture, and ipso facto, in the generation of policies for their modernization (p.31)".

Wiens, 1976, used a quadratic programming model to examine the impact of yield uncertainty on peasant allocation of land among crops and use of hired factor services such as labor and credit. Using historical data from China, Wiens demonstrated that the peasants decision making behaviour exhibited substantial risk aversion. His final conclusion is that neither risk neutrality nor liquidity constraints alone could explain both the cropping patterns and the factor employment observed among Chinese farmers.

In the African continent, the issue of risk was investigated by Wolgin, 1975, in Kenya. He demonstrated that the traditional test of economic efficiency in peasant agriculture, using marginal analysis, are generally mis-specified if farmers are making their decision in the presence of risk. Furthermore, Wolgin concluded that risk plays an important role in farmers decision making and that farmers under conditions of uncertainty behave as risk averse entrepreneurs.

Consideration of risk and uncertainty in project appraisal studies need more emphasis because it seems that so far no agreed procedure or practice has emerged. Several international organisations such as the World Bank have apparently decided that the information and analytical costs arising from rather sophisticated methods of risk analysis outweigh the benefits to be gained in terms of better decisions about uncertain projects (Anderson, 1983). The conventional methodology to account for risk and uncertainty in project appraisal is sensitivity analysis adopted by Gittinger, 1972, and Little and Mirrlees, 1974. However, sensitivity analysis per se is surely inadequate because it is based on subjective judgement about possible increments in project costs or otherwise reduction in project benefits.

Hillier, 1963, developed a project appraisal model for estimating the probability distribution of present value (PV) by using expected value E(PV) and variance V(PV). He relied on the Central Limit Theorem for approximately normal distribution of PV. By estimating the mean and variance of PV, the decision maker can evaluate the risk consequences of a particular investment. This model, however, is criticized for statistical dependencies and potential correlations of covariances.

Stochastic simulation has been the most widely used model for evaluating uncertainty in project appraisal (Anderson, 1983). Monte Carlo sampling technique for estimating the distribution of PV and internal rate of return (IRR) was also examined by Reutlinger, 1970. This approach as developed and applied by Reutlinger is based on identifying the most critical components of the project and simulating the probability of IRR under different assumptions underlying the critical components. The World Bank approaches so far has confined to Gittinger's sensitivity analysis and Reurlinger's stochastic simulation approaches.

Finally, there have been attempts to incorporate risk in agricultural sector models. Econometric models are frequently employed in determining the market-clearing prices using supply and demand equations at the sector level. Duloy and Norton, 1975, have shown how linear programming models can be adapted to solve production and marketing problems. However, a major difficulty in incorporating risk behaviour in sector supply models is the need to aggregate the individual utility functions (Simmons and Pomareda, 1975). The difficulty arises from the fact that the expected utility theorem is based on ordinal preference indices rather than cardinal measures. These preference indices are only defined up to linear transformations, and are not strictly additive over individuals. Moreover, quadratic utility functions for income cannot be added to draw inference about the whole sector. To overcome aggregation problems, economists have developed a weighted average procedure where the weights are the risk shares $\sigma_i/\Sigma\sigma_i$). Several applications of this weighted average procedure is documented in the literature by the work of

Hazell et al, 1981, Simmons and Pomareda, 1975, and Kutcher and Scandizzo, 1981.

2.6 Farmers Attributes and Elicited Preference

In addition to deriving a numerical measure of attitude toward risk, several researchers made efforts to correlate risk coefficients with a veriety of socio-economic variables.

Halter and Mason used a modified Ramson technique to elicit utility functions and compute Pratt Coefficients for 44 Oregon farmers in 1974 (Patrick et al, 1982). Eleven farm operators were analysed in regression analysis with Pratt Coefficient as the dependent variable. Percent of land owned, education and age were statistically significant and education, per cent ownership and education-age interaction factors also were significant.

The same study was repeated by Whittaker and Winter in 1980. At this time, the signs of all coefficients estimated changed significantly. It seems unlikely that the relationship between risk attitude coefficients and socio-economic variables could have changed so much in only three years. To test the hypothesis that a change in income was responsible for the change in Pratt Coefficients between the two studies, the change in the coefficient was regressed on the change in income. The R^2 was only .002 and the estimated coefficient was one-third the size of its standard error. Therefore, the change which is observed must have been related to a change in some socio-economic variable which was not included in the model. Since neither set of authors include in their reports the eight socio-economic variables which were rejected from the model on the basis of Halter and Mason's first stepwise regression, it is impossible to determine whether one, or a combination of these variables contributed to the results (Fleisher and Robison, 1985). A later study in the same region by Mason and Halter showed that acres of grass seed farmed was positively correlated to increases in risk aversion.

When Dillon and Scandizzo, 1978, determined risk attitude coefficients of a group of small owners and sharecroppers in north-east Brazil, they found that the estimated coefficients were not normally distributed. This suggests that the socio-economic characteristics of farm households, which were also not normally distributed, may account for some of the variation within each tenure group. Four socio-economic variables for which data was readily available were used to test this hypothesis. These included the farmers age, income, household size, and ethical attitude towards betting.

Utility free and utility function specific regression models were developed using a linear functional form to relate the risk premium requested by the i-th individual to the risk of the prospect presented to him in the experiment. The other variables in the model were socio-economic variables and an additive random disturbance. The utility free model, which employed the risk premium as a monetary measure of risk attitude, was run twice, once without restrictions and once with a zero order restriction placed on the socio-economic variables. A second set of models differed from the first in that the measure of risk used was the variance minus the squared certainty equivalent. In a quadratic utility framework, this is equal to the risk premium divided by the risk aversion coefficient. The set of regressions was run in unrestricted and restricted forms. The unrestricted equations provided marginal measures of risk aversion while the restricted forms provided average measures.

As in the case of the individual data, major differences exist between the values of the parameters' measures when subsistence (income required to maintain the farming unit intact) was and was not at risk. For sharecroppers, these differences extend to the entire estimated equations. For small owners, however, the estimated marginal risk aversion parameters under the two sets of circumstances are not significantly different. For both owners and sharecroppers, an increase in the riskiness of the random prospect induces an increase in the required risk premium. Increasing risk aversion was also found to be correlated with ethical beliefs against gambling, and for owners, an increase in household size. In conformity with Arrow's hypothesis of declining absolute risk aversion with increasing wealth, increases in income were associated with a fall in the requested risk premium. For both tenure groups in both situations, large risk premiums are required as risk increases.

Moscardi and de Janvry, 1977, used a set of variables to define the socio-economic characteristics of the peasant households in their sample in Peubla, Mexico. These variables included family size, age, years of schooling of the household head, the total amount of land under its control, the level of off-farm income, and membership in a "solidarity group". These solidarity groups were created in conjunction with the Peubla Project to allow peasants access to credit not as individuals but as members of a group of five to twenty members.

Discriminant analysis was used to test the hypothesis that a systematic relationship exists between attitudes toward risk and the socio-economic characteristics of peasant households. Eight-four per cent of the subjects were classified similarly by risk aversion coefficients and socio-economic variables. It was found that higher degrees of risk aversion were positively correlated with age and negatively correlated with schooling, family size, off-farm income, land under control, and membership in a solidarity group. The results support the hypothesis that the risk bearing capacity of peasants can be explained in part by their socio-economic characteristics. Particularly significant for that purpose are the extent of land under control, off-farm income, and membership in a solidarity group.

When Binswanger, 1980, regressed eleven socio-economic and structural characteristics on the partial risk aversion coefficients derived for peasants in rural India, he got some expected and some surprising results. To ensure that neither sex nor village membership affected the distributions, he first determined that estimated coefficient did not change significantly for males or females or across villages. One of the most surprising results of the regression analysis was the weakness of the relationship between physical assets, measured as the gross sales values of those assets, and risk aversion, especially given the strong effect that game size had on risk attitudes. The sign of the coefficient on wealth was consistently negative, but not always statistically significant. Wealth had little impact on behaviour at the fifty rupee game level, an amount commensurate with monthly wage levels or small agricultural investments.

Higher level of risk aversion were associated with low levels of education although the effects was not a strong one. When variables correlated with schooling, salary income and a progressive farmer dummy were suppressed, schooling had a much stronger effect. Past experiences with playing the gambles, or luck, was highly correlated with risk attitude, with success in prior games negatively correlated to increased risk aversion. The effects of "luck" did not wear off rapidly, but did tend to decrease as the stakes rose.

Increasing risk aversion was positively correlated with age at the half rupees and five rupee income levels but the two were negatively correlated at higher game levels. This result was unexpected as was the consistent result that risk aversion was not smaller for families with fewer dependents. As in the results published by Dillon and Scandizzo, tenants were shown to be less risk averse than landlords at low game levels. A negative correlation between risk aversion and transfers received, supports the hypothesis that receiving income transfers reduces aversion to risk because the transfers provided insurance against adversity.

Binswanger concluded from these results that the difference in investment behaviour observed among farmers facing similar technologies and risks cannot be explained primarily by inherent risk attitudes, but instead are induced by the existence of differing constraint sets.

As part of a study on risk efficient fertilizer application rates for farmers in Brazil, Crocomo, 1979, regressed the socio-economic variables of age, education, family size, tenure arrangement, income, size of farm, and contact with sources of information against risk aversion coefficients for 118 farmers. The only significant parameter was the information index, which was negatively correlated with increasing risk aversion. When a stepwise regression was run for all owners together, allowing for interaction terms, it was shown that increasing risk aversion was positively correlated with age, access to information, and an information-income interaction term. Increasing risk aversion was negatively correlated with increases in income, which supports Arrow's hypothesis of decreasing absolute risk aversion with increasing wealth.

CHAPTER III

RESEARCH METHODOLOGY

3.1 Data Collection and Limitation

3.1.1 Source of Data

Both primary and secondary data were used for the study. The primary data were collected through a survey by using structured questionnaire on ADP farmers. Input-output data were collected on each farm. This includes hectarages of crops, planting dates, number of weedings, quantities, monetary values earned from each crop, other sources of income, expenses and output retained for home consumption etc. Information was also obtained on farmers input use, household chateristics such as, age, family size etc. The primary data was obtained from the farming population in the 3 ADP zones. Information was also obtained from the ADP field enumerators and extension staff who assists the farmers in their farming activities.

The yearly agronomic field records of ADP, were utilized to obtain past records of crops since the inception of ONADEP. These give an estimate of yields of sole and mixed crops, cropping patterns, average prices, cost of production and gross margins for the crops. Further information was obtained from the records of Federal Office of Statistics (FOS), Federal Agricultural Coordinating Unit (FACU) and past studies on the study area.

3.1.2 Sampling Design

Although it would have been desirable as a first stage in sampling to use some theoretical formulation to obtain the size of the sample on the basis of variation of the major indices to be studied, and relate these to the cost of obtaining information; lack of apriori knowledge of these indices made this impossible. Therefore a more practicable method under the small farmer environment was utilized; A multistage stratified sampling procedure with probability proportional to farming population size of each zone was utilized to obtain a representative sample of the farmers. In stratified sampling, the population of N unit is first divided into sub-populations of N_1, N.... N units respectively. These sub-population are non-overlapping and together, they comprise the whole of population so that $N_1 + N_2 + ... + N_L = N$. The study area was stratified into its ADP categorized zones of Kajola, Irepo and Ifedapo zones. These are the sub-populations referred to as strata; and constitute the first stage of the sampling.

From the staff appraisal report of the ADP in the study area, the farming household population of these zones were estimated as 180,341, 243,204 and 265,186 farm families for Kajola, Irepo and Ifedapo zones respectively (ONADEP, 1988). From these zones, 754 wards were created and listed by the project authorities. At the second stage of the sampling, fifty (50) wards were selected in all the zones with the distribution being proportional to the size (farming population) of each zone. Thus wards were selected in each zone such that:

$$nh = \frac{n.\ Nh}{N} \quad .... \quad (3.1)$$

where

nh = Number of wards to be selected in stratum/zone h

n = Total number of wards sampled

Nh = Household population in zone or stratum h

N = Household population in ADP area.

With this design, thirteen (13), eighteen (18) and nineteen (19) wards were selected from Kajola, Irepo and Ifedapo zones respectively.

The third stage entails a simple random selection of ten respondents in each ward bringing the total sample size to 500 ADP farmers. With this design, 130 farmers were sampled in Kajola area, 180 in Irepo and 190 at Ifedapo.

3.1.3 Method of Data Collection

The data for this study was collected through a field survey between October 1989 and February 1990 by selected ADP enumerators closely supervised and directed by the researcher and two university graduates of Agricultural Economics. This arrangement lessened the data inaccuracy problems as a result of enumerators. The selected enumerators were put through the questionnaires and acquainted with the purpose of the research.

The enumerators have a rural background with a sound knowledge of the local setting and two of them also have

Diploma in Agriculture. The enumerators have motorcycles from the ADP and this made accessibility to distant farms possible. Furthermore, the collection of fairly accurate information was made less difficult as they have always been in contact with the farmers and were able to translate their local units such as "siri", "sile ile, "toro" etc. into measurable units. Constant supervision and frequent direct participation and observation of activities by the researcher during the field survey also improved the reliability of the data collected. Data were also extracted from the records of ONADEP by the researcher and the graduate assistants while some extension staff of the project were personally interviewed. Information on subjective perception of risk by the farmers was obtained mainly through the informal survey which included discussion between the researcher/enumerators and the respondents, and the observation of the constraints experienced by the farmers under their natural environment. The farmers were able to rank their risk constraints and the degree of riskiness in each crop enterprise.

3.1.4 Data Limitation

Accuracy of the data is limited by the level of illiteracy of the farmers who hardly keep records. Moreover, the fear of tax prevented some farmers from releasing information on their operations and household. The utilization of ADP enumerators who have good working relations with the farmers through their extension work minimized this problem. The questionnaires lacking vital informations were eliminated from the sample and often the experience of the enumerators were relied upon to obtain accurate information from the farmers.

There were computational problems as a result of different units from different areas of the ADP. Two quantity measures especially of inputs and outputs differ. For example, while small farmers of Kajola zone measures fertilizer input with "match box", most farmers in Irepo zone depended on the "bottle cover" as yardstick. These were however solved by picking and using ADP enumerators in a particular zone for data collection in that zone. The conversion of different measuring units of kilogrammes was thus done through them. Another limitation stems from the past records utilized in forming the risk deviation matrix. The data from ADP records were collected over a period of time probably by different enumerators and possibly using different sampling design and frame.

3.2 Model Formulation

3.2.1 Model 1: Target-MOTAD (Minimization of Total Absolute Deviation of Returns)

Risk coefficients for farmers were obtained through the output approach using a modification of linear programming model called Target-MOTAD. In the model, the farmer is assumed to evaluate risk on the basis of safety-first criteria; that is, he minimizes the probability of his farm output falling below his subsistence requirements. This safety-first criterion is introduced as a risk constraint into a linear programming model of a representative farm. The decision criterion used measures risk as mean absolute deviations from an expectation. Therefore in situations of risk, the individual farmer is assumed to be averse to risk, so that his objective function is defined by the dual criteria of maximizing expected returns and minimizing the variance of returns.

The model is a two-attribute risk and return model. Return is measured as the sum of the expected returns of activity multiplied by their individual activity level. Risk is measured as the mean of the total absolute deviations of the solution from expected return level. The total absolute deviation is then varied parametrically so that a risk-return frontier is traced (Tauer, 1983).

Mathematically, the model is stated as

$$\text{Max } E(Z) = \sum_{j=1}^{n} C_j X_j \qquad \ldots\ldots\ldots \quad (3.2)$$

subject to

$$\sum_{j=1}^{n} a_{ij} X_j < b_i \quad (i = 1 \ldots m) \qquad \ldots\ldots\ldots \quad (3.3)$$

$$T - \sum_{j=1}^{n} C_{rj}X_j - Yr \leq 0 \quad (r = 1 \ldots\ldots s) \qquad \ldots\ldots \quad (3.4)$$

$$\text{i.e} \quad [\sum_{j=1}^{n} C_{rj}X_j + Yr > T]$$

$$\sum_{r=1}^{s} prYr = \lambda \quad (\lambda = M \rightarrow 0) \quad \ldots\ldots\ldots \quad (3.5)$$

$$X, y > 0$$

where

E(Z) = Expected return of the plan or solution to the plan in N

C_j = expected return to activity j in N

x_j = level of activity j

a_{ij} = technical requirement of activity j for resource i

b_i = level of resource i

T = target level of return in N

C_{rj} = return of activity j for state of nature or observation r (N)

Yr = deviation below T for state of nature or observation r

Pr = probability that state of nature or observation r will occur

λ = a constant parameterized from M to 0

m = number of constraints or resource equations

s = number of states of nature or observations

M = large number (represents the maximum total absolute deviation of return of the model)

Eq (3.2) maximizes expected return of the solution set. Eq. (3.3) fulfils the technical constraints for the activities. Eq. (3.4) measures the revenue of a solution under state of nature (r). If that revenue is less than the target T, the difference is transferred to equation (3.5) via variable Yr. Equation (3.5) sums the negative deviations after weighing them by their probability of occurrence (pr). Since the target-MOTAD model has a linear objective function and linear constraints, the model can be solved with a linear programming algorithm. The matrix formulation of this model is shown in

Note:

$$Yr = -\sum_{j=1}^{n} (Crj - Cj)xj$$

$$\sum_{r=1}^{s} yr \leq \lambda$$

appendix 1 and 2 for small and medium farms respectively. The model is superior to other programming models under risk because it is computationally efficient and generates solutions that meet the second degree stochastic dominance (SSD) test (Tauer, 1983, Berbel, 1990).

There are two steps in the computational procedure of the model. First, a conventional linear programming maximization problem is formulated and solved to determine the maximum return without risk constraint. This gives the highest point on the efficiency frontier. Second, the element of risk is formulated as a matrix of gross margin deviations from expected returns. Points on the risk efficiency frontier are obtained by decreasing the value (λ) parametrically in arbitrary decrements. Along the efficiency frontier, the Target-MOTAD model minimizes the mean absolute deviation (MAD) for any given expected gross margins. Essentially, this minimizes the standard deviation of returns to the farm measured by the estimator:

$$\text{Std Dev.} = D \left(\frac{\pi S}{2(s-1)} \right)^{\frac{1}{2}} \qquad \ldots\ldots\ldots \qquad (3.6)$$

where

S = number of states of nature

D = estimated mean absolute deviation of returns to the farm (Hazell, 1973).

The mean absolute deviation (MAD) or D for an activity (j) and for the whole farm over all states of nature (years) is estimated respectively as follows:

$$D = S^{-1} \sum_{r=1}^{s} |(Crj - Cj)xj| \quad \ldots\ldots (3.7)$$

$$D = S^{-1} \sum_{r=1}^{s} \sum_{j=1}^{n} |(Crj - Cj)xj| \quad \ldots\ldots (3.8)$$

All variables are as defined earlier.

This transformation into standard deviation allows the model to determine a set of efficient farm plans along the E-σ or E-V efficiency frontier. In order to minimize risk while achieving optimal returns, the model selects enterprise combinations that are least risky (as measured by variance in annual returns) and/or that have negative (or less positively) correlated returns. Therefore, an estimate of each activity's level of risk or risk associated with a particular farm plan (enterprise combination) is derived by calculating the standard deviation and/or coefficient of variation for that activity or farm plan. This is done for the existing farm plan of the farmers in order to obtain an estimate of the level of risk at which the farmers are operating. Depending on a farmer's attitude toward risk, he can select the farm plan that will maximize his utility.

3.2.11 Assumptions of the Model

Since T-MOTAD basically is a linear relationship, all the assumptions of the conventional linear programming model hold except the assumption which states that resource supplies, input-output coefficients, prices of resources and activities are known with certainty. The assumptions for T-MOTAD are: (a) additivity of resources and activities; (b) linearity of the objective function; (c) non-negativity of the decision variables; (d) divisibility of activities and resource; (e) finiteness of activities and resource restrictions; and (f) proportionality of activity levels and resources.

Other assumptions associated with whole-farm planning models using MOTAD are: (1) returns or gross margins are assumed to have a normal distribution; (2) the decision maker's preference among alternative farm plans is expressed in terms of expected income E and associated variance V, therefore, his preference or utility function may be described as quadratic:

$$U = f(E,V) \qquad \ldots\ldots\ldots (3.9)$$

and (3) the indifference curves resulting from the above utility function are convex with positive slopes. This latter characteristic implies that decision makers are risk averse.

3.2.2 Model 2: Regression Model

The model formulas of equations 3.6 and 3.8 were used to derive risk coefficients for individual farmer's plan. These risk coefficients were then related to the farmers socio-economic variables through a stepwise regression analysis in order to sought an explanation for the differential degree of risk behaviour among peasant farmers. This analytical model apart from giving the quantitative relation between the variables and elicited risk attitudes, picks the variables in order of importance and contribution to the measured farm risk level. Various functional forms were fitted to the data in order to obtain the best fit. These forms are linear, semilog, exponential and double log functions.

The general functional form adopted is given by:

$Y = f(x_1, x_2, \ldots Xn)$ in order of priority (3.9)

where

Y = Estimated standard deviation of the farmer's plan

Xi = i^{th} socio-economic variable ($i = 1, 2 \ldots n$)

The socio-economic variables for determining farmers attitude to risk in this study are the following

X_1 = age of farmer in years

X_2 = years of formal education

X_3 = family size

X_4 = 0 1 dummy variable signifying marital status

X_5 = number of adult earning income in the household

X_6 = years of experience in farming

X_7 = total farm size in hectare

X_8 = proportion of cropped hectarage to total farm area

X_9 = level of off-farm income in N

X_{10} = 0, 1 dummy variable signifying membership of a community group.

CHAPTER IV

FINDINGS ON SOCIO-ECONOMIC CHARACTERISTICS OF FARMERS

This chapter presents the socio-economic picture of the farmers in quantitative terms. It is hypothesized that farmers' perception of risk determines their optimal farm plan. The optimal farm plan is also determined by many other factors such as social and economic status, access to production factors, family composition, education and years of farming experience. Therefore a critical study of the farmers' socio-economic background was explored through the field survey.

The chapter discusses the variations between farmers for all the variables that determine the nature of the farming household, income generating potential and access to formal and informal institutions. The study at the initial stage intends to distinguish between ADP contact farmers and the other farmers in terms of accessibility to current research information and inputs generally. But the survey result reveals no striking difference between these two categories of farmers apart from the nomenclature. Therefore the results as presented in this chapter applies to both categories of farmers. The ADP contact farmers are pre-selected group of farmers by the project on whose farms, on-farm adaptive research is carried out. These farmers are utilized as case study in the introduction of new technologies into the project areas.

4.1 General Background

Table 4.1 below gives an overall picture of the characteristics of farmers in the study area. The average age of the farmers is 45.32 years with a maximum age of 63 years. The minimum age which is 23 years and the average age of about 45 years may indicate the entering into farming of increasing number of young adults. This may be considered a result of the current economic recession in the country either directly as part of the benefits or indirectly as a result of unemployment problems.

Generally an average farmer in the study area has about 16 years of experience in farming and three (3) years of formal education. The difference of about three (3) hectares between average total farm size and cropped area indicates that some farmers still left their land to fallow. However, rudimentary technology restricts the level of cultivation of most farmers in the study area while some land area are not accessible. Average farm income (N2,203) that these farmers earn is considered low and most of them engage in other occupation to sustain their large family. The average off-farm income for those engaged in other economic activities is N1,023.45. The variance of 45.62 per cent within the income group indicate the degree of disparity in the generation of off-farm income among farmers. The average household size is about seven with an average of about five (5) children and one wife. However, most farmers have up to 5 wives and 10 children. Given that, out of an average of seven people in a farmer's household, only about two (2) are engaged on the farm, this tells much about labour availability during critical periods of farming operation. However, the small farm sizes reduce the possibility of this hindering the production in any particular year. In any event, the farmer still relies on hired labour at critical periods.

Table 4.1: Some Summary Statistics of Selected Variables of Respondent Farmers 1989/90

VARIABLE	MEAN	C.V(%)
1. Age (years)	45.32	21.82
2. Farming Exp. (years)	16.13	56.23
3. Years as ADP Contact Farmer	0.78	85.32
4. Formal Education (years)	2.96	82.46
5. Total Farm Area (ha)	6.42	8.02
6. Cropped Area (ha)	3.45	26.76
7. Children (No.)	5 .0	23.27
8. Household Size (No.)	7 .0	52.62
9. Farm Workers in Farmers Household (No.)	3 .0	56.32
10. Farm Income (N)/annum	2203	22.33
11. Off-Farm Income (N)/annum	1023.45	45.62

Source: Field Survey Data 1989/90

In the sample, only 21.7 per cent of the farmers were ADP contact farmers while the remaining 78.3 per cent were not contact farmers. Actually in the process of extension with principle of "teach one teach all", the strategy is to select some key farmers as contact for all extension teaching. These in turn spread it to other farmers. Thus there is little distinction between these 2 categories of farmers. Furthermore, most of farm (operation) information from ADP are written and placed at strategic places for all farmers. However the enumerators carry out on-farm adaptive research (OFAR) on the farm of only contact farmers, as case studies. But in the sample, about 95 per cent of the farmers have had one form of contact with ADP in one way or the other either through the extension classes, adult farmers education classes or their farm support units spread all over the zones.

The farmers belonged to various community associations except about five (5%) per cent of the sample. The most common farmers groups in the study area were the cooperative societies and association of young farmers and farmers club. This is without prejudice to other ad-hoc informal associations such as "Esusu", "Omo Ile", "Agbelere", "Aro" etc.

The following section considers the structure of the farmers characteristics in the study are.

4.2 Age Structure and Experience in Farming

Most farm studies have highlighed the importance and implication of age and age distribution for rural development. Both factors have a significant impact on level of crop production and technology and technology adoption. Age correlates with experience and has an influence on the decision making process of the farmer as to level of risk aversion and the extent of adoption of any innovation in farming. Kireta-Katewu, 1985, indicated that age has a direct bearing on availability of manpower on the farm, mobility of the farmers, the farm size cultivated, and the ease of adoption of innovation. Table 4.2 indicates the age structure of farmers in the study area.

Only about 6.5 per cent are young adult farmers (21-30 years) while middle aged adults (31-50 years) constitute about 51 per cent and old adults (over 50 years) are about 43 per cent of the sample. In the old adult category, about 26 per cent are in the 51-60 years age-group and about 17 per cent are already above 60 years of age. It can be observed that the farmers in the study area started farming as early as 23 years and the old farmers still constitute a large percentage of the farming population.

Table 4.2: Age Distribution of Respondent Farmers

Age Group (Year)	No. of Farmers	Percentage
21-30	20	6.5
31-40	73	23.6
41-50	83	26.9
51-60	79	25.6
61-70	54	17.4
Total	309	100.0

Source: Field Survey Data, 1989/90

The number of farming household within the 21-30 years age group are the smallest of all these age groups involved in farming while the largest number is for those who are 51 years and over. This proves that the rate of entry of the younger people into farming is very low, while the presence of many older people is still prominent.

Old age can have serious consequences for agric production if not accompanied by literacy. It can reduce the rate of adoption of innovation and slow down response of farmers to technology. However, it is also possible for age to be positively correlated with experience and enhance decision making especially under uncertainty. Table 4.3 which shows distribution of experience in farming indicates something close to this.

Given that the minimum age for farming in the sample is about 23 years, one expects an average old adult farmer to have experience of about 20 years or more. Therefore, about 43 per cent of the sample which constitute the old adults should have up to 20 years experience. Table 4.3 corroborates this fact as about 36 per cent of these farmers have above 20 years experience in farming, while the remaining 64 per cent of the population have less than 20 years experience. Further evidence is obtained from the correlation matrix of some of the variables, presented later in table 4.7. Age is positively related to farming experience and cropped area, but negatively correlated with amount of loan obtained for farm work.

Table 4.3: Distribution of Respondents' Farming Experience in Years

Farming Experience (Yrs.)	Frequency	(%) Percentage
1-5	41	13.2
6-10	70	22.7
11-15	57	18.4
16-20	30	9.7
21-25	39	12.6
26-30	11	3.6
31-35	26	8.4
36-40	35	11.4
Total	309	100

Source: Field Survey Data, 1989/90.

4.3 Household Size

The household size of farmers which is considered as members of the nucleus family and of the extended family living with the farmer is a critical factor in small farmers operation in the country. This is because, it determines the availability of labour for farm operation and also the amount of crops for sales from the farm. The average household size in the sample as indicated in Table 4.1 is 6.67 with a coefficient of variation of 52.62 per cent. This implies that variation in family sizes within the sample is relatively stable. Majority of the farmers (49 per cent) have between 6-10 people in the household while those with more than 10 members are about 19 per cent of the sample as indicated in table 4.4 below. This result shows similarity to the earlier study conducted in this zone by Akatugba (1986).

The number of wives per farmer tends to be positively correlated with household size and therefore a potential for labour supply. In the farming area, the average number of wives is about one (1) while the average number of children is about five with a coefficient of variation of 23.27 per cent. From tables 4.4 and 4.5, majority of the farmers marry one or two wives while about 7 per cent are single.

Table 4.4: Distribution of Household size and Associated Cropped Areas in hectare

Household Size	Frequency	% (Percentage)	Average Cropped Area (ha/Household)
1-5	101	32.7	2.56
6-10	150	48.5	4.35
11-15	47	15.2	6.20
16-20	11	3.6	10.2
Total	309	100	

Source: Field Survey Data, 1989/90.

Table 4.5: Number of Wives of Farmers

No of Wives	Frequency	% (Percentage)
None	21	6.8
1	168	54.4
2	113	36.6
3	7	2.1
Total	309	100

Source: Field Survey Data, 1989/90.

Also 37.8 per cent of the population have less than 5 children while 62.2 per cent have above 5 children.

Table 4.6: Distribution of children per Farmer

No. of Children	Frequency	% (Percentage)
None	21	6.8
1-5	98	31.7
6-10	161	52.1
11-15	29	9.4
Total	309	100

Source: Field Survey Data, 1989/90.

Household size becomes an important issue in the studies of small farmers when one realises that it is an indication of the amount of food to produce. A farmer with a larger household requires more food than the one with a smaller one and therefore is likely to cultivate more crops, utilize more land to attain a higher food production. Also related to this, is the fact that this category of farmers are likely to have a little surplus for sale and obtain more loan than other farmers.

From the consumption unit concept, one can calculate the consumer/worker ratio. This is defined as the ratio of household size to the number of persons that work on the farm. Therefore, in explaining labour inputs, this ratio is only valid in relation to the agricultural fieldwork. From table 4.1, with an average household size of 6.67 and average family farm worker of 2.55, the consumer/worker ratio in the study area is 2.61. In other words, for every worker on the farm in the study area, there are about 3 dependants waiting to feed on his proceeds.

This ratio is still moderate for meaningful rural development and productivity but the heavy reliance of farmers on rudimentary hand tools for field work worsens the situation. The inverse of the ratio indicates labour availability in the study area from the farmers household. This means that members of the farmers household participating in farm work can be calculated as percentage of the household size. It indicates that an average of 38.2 per cent of family members is available for farm work.

4.4 Land Availability and Cropping Patterns

The most common and productive resources in small holder agriculture are the land and labour resources. Land availability is determined by population, the land area, topography and the tenural system operating in an area. Topography in conjuction with climate, technology and economic factors determine the types of crops and cropping pattern available in that area. Cropping patterns indicate the yearly sequence and spatial arrangement of crops on a given land area. The socio-cultural factors and farm households influence this patterns in any environment and make it difficult from one ecological zone to the other. This results in specific and interacting cropping patterns. In the study area, the cropping patterns in order of priority or commonality are as shown in table 4.7.

Table 4.7: Distribution of Respondent Farmers by Cropping Pattern, 1989/90

Cropping Pattern	LABEL	% of Farmers Cultivating Crop	Average Cultivated hectarage per Farmer
Sole Maize	MZE	98.43	0.92
Sole Yam	YAM	98.12	0.80
Sole Cassava	CSV	97.37	0.32
Sole Sorghum	SGM	86.12	0.46
Maize/Cassava	MZE/CSV	86.03	0.08
Maize/Sorghum	MZE/SGM	85.47	0.09
Maize/Melon	MZE/MEL	68.26	0.07
Maize/Sorghum/Cassava	MZE/SGM/CSV	67.89	0.12
Sole Melon	MEL	57.32	0.02
Sole Cowpea	LCP	52.22	0.06

Source: Field Survey Data, 1989/90.

From the distribution of the cropping patterns in table 4.7, the following observations emerge. First is the fact that the major cropping pattern are based on maize production. In addition, almost all the farmers cultivate Sole Maize and Sole Yam. There is also prominence of annual crops in each crop mixture. This practice in a mixture ensures some degree of diversification; a way of hedging for risk.

Few farmers cultivate cowpea and melon mixed with other crops such as cassava and maize. However, these are insignificant in the sample. Most of them who ventured into cowpea production preferred them sole to allow adequate care and application of insecticide. They however, seldom apply fertilizer to cowpea and melon.

Table 4.8 highlights the nature of land ownership pattern in the study area. About 52 per cent of the farmers obtain their land through the extended family system. The land tenure system is therefore still a special feature of these farmers production. 24.6 per cent got their land through inheritance while only 1.3 per cent pays rent on land for their farming.

Table 4.8: Land Tenure System Profile and Perception on Expansion possibilities in the Study Area

Mode of Land Acquisition	No. of Farmers	% (percentage)	Expansion Possibility No. of Farmers	Expansion Possibility Percentage
1. Family Land	159	51.5	32	10.35
2. Rent/Lease	4	1.3	277	89.6
3. Gift	70	22.6		
4. Inheritance	76	24.6		
Total	309	100	309	100

Source: Field Survey, 1989/90.

Further enquiry shows that the rent is mostly in kind, paid at the end of the crop year in form of part produce from the farm. Few farmers however complement this with between N40 - N120 per acre as rent. About 23 per cent of the farmers also received their land as gift from in-laws to farm for a period of time. This type of gift is not a permanent kind and the land is only released for as long as the owner has no serious need for it or pressures from other family members for its use. Further examination of means of expansion for these farmers as shown in Table 4.8 indicates that only about 10 per cent hope to get more land through family land while the majority of 89.6 per cent only depend on rent land, if available. This further shows the nature of primary production in the study area. The farmers have fragments of farm holdings mainly from the family land and it is practically impossible to expand production through acquiring more family land even if available. Land tenure system still predominate small farmers operation and land available to a farmer for arable farming vary from year to year.

4.5 Farm Size

For this study, farm size is expressed in two ways. The first one called farm area is the amount of land actually available to the farmer for cultivation. This includes cultivated land, land for fallow and land left uncultivated either due to poor finance or low production capacity of farmers. The second farm size is the land utilized by the farmer for cropping practices and is expressed as the cropped area.

From Table 4.1, the average farm area in the study area is 6.42 hectares while average cropped area is 3.45 hectares. Average cropped hectarages of different cropping patterns are also as given in Table 4.7.

It is evident from the table that maize and yam cultivation are most prominent in the region and take the highest average of 0.92 and 0.8 hectares respectively. This is folowed by cassava with about 97 per cent farmers cultivating. Mixed cropping is also very common and maize is usually planted mixed with other crops. There are other crop combination such as Yam/Melon and Maize/Cassava/Cowpea in the study area but only few farmers in the sample cultivated such combination of crops.

Table 4.9 indicates that 68.0 per cent of the small farmers cultivates below and up to 2 hectares while about 32 per cent cultivate 2.01 hectares and above. Farmers with farm size up to 5 hectares constitutes the majority and form 67.7 per cent of the sample. The farmers with large farm area between 5.1 and 8.0 hectares are only 5.5 per cent of the total farmers. The R - value which indicates the intensity of land cultivation (Ruthenberg 1976) in the area gives an intensity of about five (5) per cent for the study area.

$$*R - \text{Value} = \frac{\text{Average Aggregate of Cropped Area}}{\text{Average Total Farm Size}}$$

Footnote:

Average Aggregate if Cropped Area = 0.35 hectares
Average total farm size = 6.42 hectares
*R Value = 0.35/6.42 = 0.054

Table 4.9: Distribution of Farm Sizes and Cropped Area

Hectarages	Farmers Count for Total Farm Area	% (Percentage)	Farmers Count for Cropped Area	% (Percentage)
up to 2.0	209	67.6	210	68.0
2.1-4.0	51	16.5	64	20.7
4.1-5.0	32	10.3	35	11.3
5.1-8.0	17	5.5	17	5.5
Total	309	100	309	100

Source: Field Survey Data, 1989/90.

4.6 Capital Resource

Due to subsistence nature of small farmers production and the rudimentary technology, very little capital input is employed in crop production. The capital inputs consist of simple hand tools and equipments; and little cash. Some often obtain loan at a high interest rate usually from money lenders. The farm tools consists of hoes, cutlasses, shovels, axes, knives etc. In the sample, 26.2 per cent obtain loan while the remaining 73.8 per cent do not. This is shown in Table 4.10 below.

Table 4.10: Distribution of Farmers by Loan Procument from Formal Sources

Amount of Loan (N)	No. of Farmers	% (Percentage)
None	228	73.8
1-500	7	2.3
501-1000	21	6.8
1001-1500	23	7.4
1501-2000	19	6.2
2001-2500	8	2.6
2501-3000	3	0.9
Total	309	100

Source: Field Survey Data, 1989/90.

From table 4.10, the average loan obtained ranges from N100 to N3,000 and about 74 per cent of the farmers do not obtain loan from formal sources for their production, while only 3.5 per cent of the remaining farmers that secure loan got amount above N2,000. This indicates how insignificant loan is, in their production. Field interview however indicated that most farmers actually applied for loan but could not get it while some farmers could not stand the stringent conditions of the money lenders. Further analysis of the farmers that obtained loan from table 4.11 indicate that amount obtained is positively correlated with farm size, cropped area and farm income. It is however negatively correlated with age and farming experience.

Table 4.11: Correlation Matrix of Farmers' Selected Variables

	Age (yrs)	Farming Years	Total Farm Area (ha)	Cropped Area (ha)	Non-Farm Income (N)	Farm Income ~~(N)~~	Loan Obtai-ned (N)
Age (Yrs)	1.0						
Farming Years	.67	1.0					
Total Farm Area(ha)	.18	.28	1.0				
Cropped Area(ha)	.14	.17	.70	1.0			
Non-Farm Income (N)	-.19	-.24	.14	.19	1.0		
Farm Income (N)	-.14	-.035	.33	.33	.23	1.0	
Loan Obtained (N)	-.006	-.08	.08	.08	.14	.03	1.0

Source: Field Survey Data, 1989/90.

The older farmers with much experience do not obtain loan while loan procurement is common with the young adult farmers. If it is assumed that these two categories of farmers have equal access to loan, then, the latter are much more willing to take risk. The low value of the correlation coefficients may be an indication that a proportion of this loan is not actually utilized on the farm, a situation that may also be responsible for its positive correlation with income from other occupation.

4.7 Farm Income

The land cultivated, cropping system, economic condition and technology in place at a particular point in time affects the income derivable from farming. Most farmers in the study area cultivates small farms and use rudimentary technology. The income profile of the farmers is shown in Table 4.12.

Table 4.12: Classification of Farmers by Income Group and by Income Source

Income Group (N)	Farm Income No. of Farmers	Farm Income % of Total	Off Farm Income No. of Farmers	Off Farm Income % of Total
Up to 1000	122	39.5	147	47.6
1,001-2,000	60	19.4	93	30.1
2,001-3,000	87	28.2	37	12.0
3,001-4,000	24	7.7	22	7.1
4,001-5,000	16	5.2	10	3.2
Total	309	100	309	100

Source: Field Survey Data, 1989/90.

It can be observed that about 39 per cent farmers in the sample earn below N1,000 as farm income annually while only 12.9 per cent earn above N3,000 annually. On further examination, it was discovered that the low farm income was as a result of bad harvest and often low output prices. It resulted from the earlier mentioned small holdings and poor technology. It was also found out that majority of these farmers augument their income with off-farm activities or other occupations such as blacksmithery, carpentry, tailoring etc. There was no single farmer in the sample without a separate supporting occupation to farming. A profile of these off-farm income shows that most of the farmers derive a significant proportion of their total annual income from other supporting occupations. Land tenure system may have contributed to this low earnings from farming as majority of the farmers have no means of expanding their cultivated land area. From table 4.12, about 10 per cent of the farmers earn more than N3,000 from off-farm employment.

4.8 Education

Majority of the farmers in the study area have no formal education. However, most of them have attended extension classes and adult literacy classes organised by Agric Development Project (ADP). Approximately 8 per cent of the sample had elementary primary education while 4.2 per cent had formal education above the primary school level as shown in Table 4.13.

The presence of about 0.29 per cent of the farmers with over ten years of formal education in the sample confirms, the recent theory of injection of young school leavers from Polytechnic, Colleges of Education and Universities into farming. The difficult economic situation in the country and unemployment problems are forcing these new category of farmers into the occupation. However, these new breeds of farmers, believed to have a high potential to take risks are still constrained by the available extended family land for cultivation.

Table 4.13: Distribution of Farmers by Level of Education

Years of Formal Education/Training	Frequency	Relative Frequency
1. 0	201	65.04
2. 1-6 years	25	8.09
3. 6.1-10 years	13	4.2
4. Over 10 years	3	0.97
5. ADP training class/ Adult literacy classes only	67	21.7
Total	309	100

Source: Field Survey Data, 1989/90.

CHAPTER V

DERIVED OPTIMAL FARM PLANS UNDER RISK

In farm planning, the farmers have two alternative decision criteria. One is to allocate resources so as to maximize cash returns to fixed farm resources; while the other is to allocate resources so as to maximize utility by striking some balance between increasing expected income and minimizing income variability to reflect risk behavior (Foster and Holt, 1990). In the first case, deterministic linear programming models can be used to derive the profit maximizing solution. However the principal criticism leveled against using deterministic models as planning tools relates to the embodied assumption that all coefficients are determined with perfect knowledge (Foster and Rauser, 1991).

In the second case concerning risk behaviour, farmers are expected to be risk averse and to maximize utility. Risk programming models, have therefore recognised the importance of risk in agricultural planning and have led to the development of a normative decision theory based on inclusion of stochastic elements in whole farm planning models. The framework for this study is based on incorporating such stochastic elements to evaluate the planning process in a risky environment. This chapter presents and discusses a set of risk efficient farm plans derived from representative farms in the study area.

The analysis is based on the assumption that farmers bear the risk associated with income fluctuations overtime. They base their plans on the long term mean of net returns and any deviation from the mean is a random event. The decision on how much area should be devoted to each crop is predicted by the model depending on resource endowment.

The Target-MOTAD Programming (L.P.) model was utilized in analysing the expected return - risk trade off for the farmers. The objective of the model is to maximize expected income under risk. The model was initially operated without risk consideration and risk was then gradually introduced. The risk portion of the L.P. model was formulated using the Expected Return-Absolute Deviation (E-A) criterion. The E-A efficient frontier was derived by parametrically varying the pre-specified level of the constant (λ) to the maximum of Total Absolute Deviation of Returns. An efficient frontier is defined as the locus of maximum expected income for each level of risk or alternatively, the minimum amount of risk associated with each level of expected returns.

There were two major data requirements for the operation of the model. The first concerned the specification of constraints for the average farm. The second relates to the deviations of the gross margins from their expectations. The deviations were required for the estimates of the trade-off between expected income and variation of returns. The derivations of these deviations are discussed fully later in the chapter. The target return was also set at N2,000 for small farm and N3,000 for the medium farm. These are the selected targets for which the income of farmers must not fall below.

5.1 Derivation of Technical Coefficients

Theoretically, farms in management studies are chosen and classified according to the factors assumed to be representative of the peasant population in the region. Often interests are on those factors that influence level of production. Farm size is the most often used criterion for classification. Distinctions can also be made on the basis of labour and capital availability, labour utilization, managerial characteristics of the farmer or average annual income. Farm size was utilized in this study to classify the farmers. From the data collected, farms were sub-categorized into small farm (Less than 2 ha) and medium farm (2.01 - 5 ha). This gives an average farm size of 1.24 ha and 3.3 ha. for small farm and medium farm respectively.

Farm management data was collected on all the farms selected for the study. Due to the preference eliciting nature of the study, 525 questionnaires were administered while only 309 (209 sample size for the small farm and 100 for the medium farm) were eventually utilized after eliminating others without complete information or with large farm size. The nature of the study necessitated certain standard level of information from the farmers and where this is found inconsistent and incomplete, such questionnaires were eliminated during coding.

5.1.1 Production Activities

The production activities take up the set of production choices open to the farmer. It comprises alternative crop activities in the study area. The cropping patterns in the study area have been summarized in chapter V. Sole yam and sole maize dominated the cropping pattern with maize often planted in mixtures. The crop activities used in the matrix include maize, yam, cowpea, sorghum, melon and maize (sole and mixtures). The study covers a growing season of one year for both early and late crops so as to incorporate such crops as yam and cassava that span both periods.

Crops planted in pure stands were distinguished from crops in mixture and the different crop cultivation activities were defined in terms of individual production function

relating input to output. The labels or definition for the crops/crop mixture are given in appendix 3.

5.1.2 Labour Coefficients

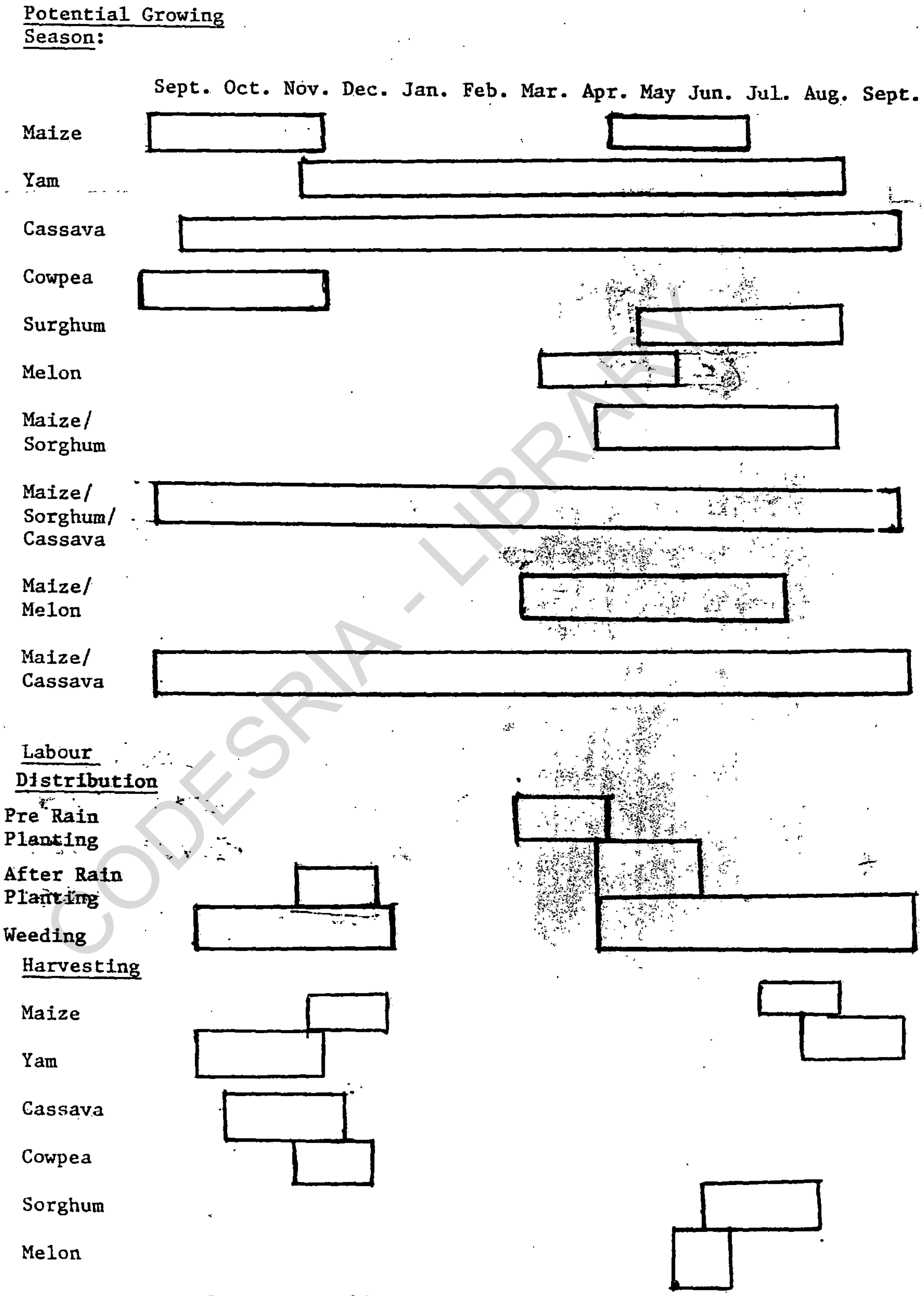
In subsistence farming, the most important and critical time related resource is the amount of labour (family and hired) available for production. The application of labour in this setting is influenced by the amount, timing and efficiency of the labourer, all of which are difficult to differentiate in specifying production function considering problem of data specification. In the study therefore, farm labour was separated into family and hired labour. The average wage rate for hired labour was N12.5 per manday.

In the model used for the study, cropping season of the year was divided into different time periods with distinct labour activities. These activities include land preparation and planting, fertilizer application, hand weeding and harvesting. Each activity is associated with a particular time period for each crop. These time periods are differentiated as quarterly periods of the year as follows:

January/February/March	-	1st period
April/May/June	-	2nd period
July/August/September	-	3rd period
October/November/December	-	4th period.

The schematic diagram of labour distribution during the periods is as shown in figure 5.1 The figure depicts the growing season of crop, the labour distribution and harvesting

Figure 5.1 **Schematic Representation of Crop Growing Seasons and Potential Labour Distribution in the Study Area**



Source: Field Survey Data

period. Maize is normally planted twice in the year while the cultivation of yam and cassava span the whole year. From the figure, the critical periods (months) for labour utilization are August, September to October and April, May, June. These are times when crops compete for available labour resources, for planting, weeding and havesting. These periods also record high wage rate for hired labour, and cash constraint which delayed the critical operation at these period could reduce the yield of crops considerably. Yam cultivation is especially more labour demanding than the other crops and delay in its staking and harvesting reduces its yield. The total labour utilization per crop is however reduced by the practice of planting crops in mixture, as the period and number of weedings are reduced considerably. The estimated total labour used during the growing season for each enterprise is shown in table 5.1 below:

Farmers in the study area use crude implements for all their operations and therefore, take up to two or three weeks to plow and plant one hectare of land. The drudgery of the farmers was however, reduced by the common savanna vegetation spread within the region. The labour coefficients for weeding were more complex to determine as there are differences in weeding requirements between crops and also the timing of the operation and its intensity have a potential impact on yield levels.

Differences in times of weeding often results in differences in amount of labour required. This is due to the fact that the longer the weeds were left to grow, the more labour would be required to weed the farm. Also weeding during the rain is expected to be easier and may require less mandays than weeding on dry planted land.

Since labour data was not detailed enough to separate all these differences, the sample mean was used in each case to represent labour requirements for weeding different cropping patterns. Labour requirements for harvesting was also taken as a sample mean for each cropping pattern.

Table 5.1: Average Labour use for Growing Season by Crops

CROP/CROP MIXTURE	TOTAL LABOUR UTILIZATION (MANDAYS/ HA/GROWING SEASON)
(MZE)	70
(YAM)	195
(CSV)	98
(LCP)	60
(SGM)	65
(MEL)	59
(MZE/SGM)	120
(MZE/SGM/CSV)	145
(MZE/MEL)	96
(MZE/CSV)	143

Source: Survey Data, 1989/90.

5.1.3 Capital Constraints

Subsistence agriculture is characterised by low level of capital utilization. There is little capital investment especially in purchased inputs. Fixed capital requirements involves a number of hoes and cutlasses and often axes. But working capital varies among farmers. They may have to purchase seeds and fertilizers. Few farmers in the sample use insecticide and only for sole cowpea production. In the model, capital requirement for seed, insecticide, and fertilizer are included as a constraint.

5.1.4 Risk Coefficients

The prices used in computing the Gross Margin for 1989/90 for the model were the sale prices of individual farmers which vary according to the period of sale. Yield estimates were also based on average of individual farmers output and the hectarages cultivated. The computation of the Gross Margin for the crops and crop mixture for 1989/90 is shown in Appendix 4 as obtained from field survey. From field survey estimations, an approximate yield conversion factors were also obtained for mixed crops as indicated in Appendix 5.

In the risk formulation for the model, both yield and price variability were considered. Price, cost and yield data of ADP for the zone for a 6 year period, 1983-1988 were utilized for variability in income of the farmers. Both variables (Yield and Price) were utilized in this study because various studies (Anderson and Hamal, 1983, Shurle and Erven, 1979, Marra and Carlson, 1990) have pointed out the fact that the small farmers were becoming more sensitive to both price and yield variability rather than yield alone. Farmers would therefore be expected to be sensitive to both production and value variability. Moreover, for the purposes of policy, the relevant determination is the right incentives to increase cultivation and make small farmers production much more market oriented. The Yield, Price and variable cost utilized in obtaining Historical Gross Margin series for the study area are indicated in appendices 6 and 7. These are obtained from the ADP records. The computed historical gross margin matrix for the 7 year period is also shown in Appendix 8. These Gross Margin series were deflated using GDP deflator to reflect 1989 constant prices. The deflators are indicated in Appendix 9 while the deflated Historical Gross Margins are shown in Appendix 10.

The risk coefficients were obtained by determining the positive and negative deviations of the yearly net returns from the expected returns formed as the average of returns. The yearly deviations utilized in forming risk coefficients as computed from ADP records and Appendix 10 are shown in table 5.2. From these deviations, the Mean Absolute Deviation

TABLE 5.2 EXPECTED GROSS MARGIN DEVIATION MATRIX 1989 PRICES

CROPS/YEARS	N EXPECTED G.M.	1983/84 1	1984/85 2	1985/86 3	1986/87 4	1987/88 5	1988/89 6	1989/90 7	MAD*
MZE	894.32	-457.63	42.56	86.44	349.7	-32.66	448.08	-436.49	264.79
YAM	809.02	-266.44	-316.97	-195.96	-291.08	-62.63	544.14	588.92	323.73
CSV	675.17	-417.31	-276.87	-248.22	-194.73	-6986	494.21	711.76	344.71
LCP	104.3	-161.79	-152.26	-39.16	-32.2	-15.67	101.78	299.3	114.59
SGM	146.07	-126.4	-81.44	-4.94	-8.82	-40.73	157.01	105.66	75
MEL	-39.34	-249.82	-220.71	217.98	151.95	-12.03	175.32	241.22	181.29
MZE/SGM	979.01	-815.83	-398.45	-132.86	-3.49	-309.52	1365.5	294.65	474.33
MZE/SGM/CSV	2474.29	-996.62	-7.89	303.61	671.31	1157.19	21.31	-1148.89	615.26
MZE/MEL	1019.30	-797.31	-297.97	-204.15	12.84	-269.16	1552.42	2.96	448.12
MZE/CSV	1201.63	-329.99	166.21	256.95	458.2	750.69	-647.08	-654.93	466.29

* Mean Absolute Deviation of Return of Crops

Source: Computed from Deflated Gross Margin Series (Appendix 10)

(M.A.D.) is computed and indicated in the last column of table 5.2.

Appendices 11-19 show graphically, the trend in, yield of sole and mixed crops, and gross margin of crops for the 7 year period. Sole maize and sole yam gave a consistently high yield over the years while yield of melon tends to be constant. Cassava and maize gave higher yields when planted mixed together than with any other crops. This may probably be the effect of cover and weed control with mixed cropping. In terms of the estimated gross margin, the combination of maize/cassava also recorded higher gross margins in all years when compared with other mixed crops.

5.1.5 Risk Measurement Statistics

In this study, risk is measured by the statistics of Mean Absolute Deviation (MAD), standard deviation (SD) and Coefficient of variation (CV). For every value of the constant (α) specified along the efficiency frontier, the Target-MOTAD model solves for the maximum expected income that satisfies all the model constraints. The MAD is then transformed into an estimate of standard deviation by the model. Standard deviation measures the despersion or variability of expected income. With higher income, the variance increases and therefore, the standard deviation. The coefficient of variation statistic provides a measure of relative variability expressed as a percentage and calculated by dividing standard deviation by expected income. The selection of best farm plan along the risk efficiency frontier depends on individual farmer's perception of risk and his resource endowment.

5.1.6 Minimum Food Constraints

It is a well known fact that the small farmers produce primarily to satisfy household requirements for food. It is the excess after domestic consumption that becomes marketable surplus. Therefore any farm plan without provision for minimum home food requirement is faulty. The model therefore, provides for minimum food requirement for home consumption.

This minimum food requirement was determined based on average consumption quantities indicated by the farmers.

5.2 Production Risk and Enterprise Combinations

Profit maximizing linear programming based on data of representative farms has been used frequently for finding optimum use of farm resources and combination of enterprises. However, due to risk involved in different profit outcomes, most of the plans fail to adequately represent behaviour of the farmers. This section tries to work out risk efficient set of plans for categorized small and medium farms of subsistence farmers. As the world of reality is marked by uncertainty due to variability in yield and prices, the section suggests an efficient enterprise system as an important way to improve the growth prospects of farm-firms and hence the farm economy of the study area. It is an attempt to maximize returns under conditions of risk and uncertainty.

The Target MOTAD formulation used in this respect becomes useful because decision makers often wish to maximize expected return but are concerned about returns falling below a critical target. Two farm size categories were considered based on data collected from the study area: Small farm; less than 2 ha and medium farm; between 2.01 and 5 ha. Given the target level, set for small and medium farm, only three plans were feasible in the risk minimized set for the small farm while four (4) plans were feasible for the medium farm. In the tables that follows, the first plan refers to the existing plan of farmers, while the last plan in each set represents the profit maximization plan. The middle plans are from parametric programming with target-MOTAD model and were risk efficient. Thus plans II to IV for the small farm and plans II to V for the medium farm are risk efficient plans.

This study assumed that risk in returns arises from price and yield factors. It is therefore an improvement on studies of Walker, 1981, Crawford, 1982, and Mruthyunjaya and Sirohi, 1979, which consider risk due to yield variation only. In the risk model, the farmer decides between possible crop combinations on the basis of expected returns and the absolute deviation of returns for each crop from its expected value. Table 5.3 presents the resource position of small and medium farms. It could be seen that the average operated area for small and medium farm were 1.24 ha. and 3.33 ha. respectively. The available family labour for small farm which was based on average household size was also 228 mandays while the average working capital utilized for farm operation of clearing, purchased inputs and weeding is N700 for small farm and N1,987 for the medium farm.

Table 5.4 and 5.5 present the existing and normative plans for small and medium farms respectively. The existing farm plan is the farmers' plan as practiced on the various farms based on average of each group.

Normative plans V and VI in tables 5.4 and 5.5 respectively are based on the profit maximizing model. They are therefore likely to be selected by a risk neutral decision maker. These plans have the highest expected returns and hence the highest risk. Interestingly, the plan also has the highest cropping intensity compared with all other parameterized risk minimized plans for the small farm size category. However, the cropping intensity under this plan is much nearer the existing plan intensity both in the small and medium farm. In fact, in the medium farm size category, the cropping intensity of the existing plan is higher than this optimum.

Table 5.3 Availability of Different Resources for the Small and Medium Scale Farms

RESOURCES	SMALL FARM	MEDIUM FARM
(a) Average Cultivated Area (Ha)	1.24	3.33
(b) Family Labour Utilized (Mondays/Ha/Growing Season)	228	322
(c) Utilized Hired Labour (Mondays/Ha/Growing Season)	210	234
(d) Utilized Working Capital N/ Ha/Growing Season	700	1987

Source: Field Survey Data 1989/90

In the small farm, the maximum attainable income with this plan considering the resource situation in the study area is N3,046.24. It is also associated with the maximum variability over 7 years measured by TAD at N19,045.06. The plan utilizes 0.27 hectares of yam, 0.09 hectares of cowpea and 0.88 hectares of maize/sorghum/cassava (M/S/C). In the medium farm, however, the hectarages of these crops increases in the optimal plan and there was an addition of 0.52 hectares of melon. The limiting constraint in this plan is the credit constraint.

As the TAD is reduced and parameterized from N19,045.06 to zero, a set of risk minimized efficient plans were generated. These are feasible plans II to IV in table 5.4 and plans II to V in table 5.5. The plans cover a wide range of available choice option for the decision maker on the basis of enterprise combination and resource allocation. The farmer has to judge the suitability of any plan based on the trade-off between expected income and the variance of income.

As TAD was decreased from plan V to II, expected income or return also decreased. In plan IV at TAD of N16,188.25, the expected income in the small farm is N2,847.6 while the return is N5,364.18 in the medium farm at plan V. Maize/Melon and Maize/Cassava enter the solution in the small farm in addition while only maize/melon enter the solution in the medium farm. The areas under cultivation of crops that came into solution in normative profit maximization plan decreased accordingly. This implies the high variability associated with the production of cowpea in the small farm; and to some extent yam and in the medium farm. As risk in terms of variability is reduced, the areas under cultivation of these

TABLE 5.4 EXISTING AND OPTIMAL RISK MINIMIZING PLANS FOR SMALL SCALE FARM (1.24 HA) IN OYO NORTH ADP AREA

ENTERPRISE		EXISTING SITUATION I	II	RISK MINIMIZING PLANS III	IV	PROFIT MAXIMIZING PLAN V
Net Return	₦	1047.2	2422.7	2532.5	2847.6	3046.24
MZE	Ha	0.12 (9.76)	-	-	-	-
YAM	Ha	0.15 (12.19)	0.27 (22.25)	0.27 (21.95)	0.27 (21.95)	0.27 (21.77)
CSV	Ha	0.14 (11.38)	-	-	-	-
LCP	Ha	0.07 (5.69)	0.08 (6.66)	0.08 (6.50)	0.08 (6.50)	0.09 (7.26)
SGM	Ha	0.15 (12.19)	0.12 (10.0)	0.09 (7.31)	0.03 (2.43)	-
MEL	Ha	-	-	-	-	-
MZE/SGM	Ha	-	0.1 (8.33)	0.04 (3.25)	-	-
MZE/SGM/CSV	Ha	0.12 (9.76)	0.49 (40.83)	0.63 (51.22)	0.75 (60.98)	0.88 (70.97)
MZE/MEL	Ha	0.08 (6.50)	-	-	-	-
MZE/CSV	Ha	0.40 (32.52)	0.14 (11.66)	0.12 (9.75)	0.10 (8.13)	-
Cropped Area	Ha	1.23	1.20	1.23	1.23	1.24
Total Percentage		(100)	(100)	(100)	(100)	(100)
Cropping Intensity		99.19	96.78	99.19	99.19	100

Note
Figures in Parenthesis represent the Percentages of the Cultivated Area

TABLE 5.5 EXISTING AND OPTIMAL RISK MINIMIZING FARM PLANS FOR MEDIUM SCALE FARMS IN (3.33HA) OYO NORTH ADP AREA

ENTERPRISE	EXISTING SITUATION I	II	RISK MINIMIZING PLANS III	IV	V	PROFIT MINIMIZING PLAN VI
Net Return	3127.29	3488	4066.7	4617.8	5364.18	5646.5
MZE	0.67 (20.12)	-	-	-	-	-
YAM	0.30 (9.0)	0.43 (12.93)	0.42 (12.72)	0.42 (12.65)	0.42 (12.65)	0.43 (12.95)
CSV	0.29 (8.70)	-	-	-	-	
LCP	0.26 (7.80)	0.53 (15.96)	0.53 (16.06)	0.53 (15.96)	0.53 (15.96)	0.53 (15.96)
SGM	0.32 (9.60)	0.45 (13.55)	0.29 (8.78)	0.14 (4.22)	-	-
MEL	0.14 (4.20)	0.38 (11.45)	0.42 (12.73)	0.46 (13.86)	0.52 (15.66)	0.52 (15.66)
MZE/SGM	0.52 (16.81)	-	-	-	-	-
MZE/SGM/CSV	0.12 (8.70)	0.63 (18.93)	0.84 (25.45)	1.05 (31.62)	1.32 (39.76)	1.84 (55.42)
MZE/MEL	0.25 (7.51)	0.90 (27.11)	0.80 (24.24)	0.72 (21.69)	0.53 (15.96)	-
MZE/CSV	0.25 (7.51)	-	-	-	-	-
*Total Cropped Area	3.33	3.32	3.30	3.32	3.32	3.32
*Cropping Intensity	100	99.6	99.09	99.6	99.6	99.6%

*Figures in Parenthesis represents the Percentages to the Cultivated Area crops are reduced. In the medium farm, cash was also constraining in all the plans.

Generally, it could be observed from these tables that when farmers shift from existing to risk minimized plans, cropping activities decreased in both small and medium farms. In the small farm, sole maize, cassava, melon and maize/melon did not enter the optimal plan while sole maize and cassava did not enter the risk minimized plans in the medium farm. From plans II to IV in the small farm, the hecterages cultivated of yam do not change appreciably while there is a change in that of cowpea, sorghum and M/S/C. In the medium plan, yam and cowpea cultivation show little change as income increases while hecterages under cultivation of melon, M/S/C/ increases with income.

The impact of diversification through mixed cropping could be derived from these plans. All the mixed cropping patterns except m/s/c enter farm plan in reduced hecterages as expected return increased. Thus the earlier farm plans II and III include the mixed crops in higher hecterages than the subsequent plans with high returns. This is an indication that the mixed crops are less risky enterprises, they enter the optimal plans in increased hectarages as income variability is reduced.

Table 5.6 presents the optimal value of plan or returns to fixed farm resources in the plans. The table also shows the estimates of minimized standard deviations and coefficient of variation corresponding to these plans. The latter indicates the estimated risk level of operation under each plan. It measures variation in return and reflects the change in risk accompanying increased hecterage of the higher risk enterprises. It is observed that under the existing farm plan, the farmers are operating at a risk level of 56.32 per cent for small farm and 50.79 for the medium farms. This high level of risk can however be reduced if farmers adopt plan V in small farm or plan VI in the medium farm which is the profit maximized plan. However risk can be averted if farmers opt for enterprise mix with less variability in returns to fixed farm resources (plans II to IV).

Land utilization in the small farm was higher in plans IV and V than the first few plans. This may be due to the model formulation. In the first few plans, smaller incomes are expected with greater concern for risk. Therefore less risky

TABLE 5.6 RISK AND RETURN LEVEL OF DIFFERENT FARM PLANS

	FARMER PLAN I	RISK MINIMIZING PLANS II	III	IV	PROFIT MAX. PLAN V
Small Farm					
(a) Return to Fixed Farm Resources (R) (N)	1047.2	2422.7	2532.5	2847.6	3046.24
(b) Minimized Standard Deviation (SD) (₦)	589.8	560.46	822.42	974.72	1169.64
(c) Coefficient of Variation of Return (%)	65.32	23.13	32.47	34.22	38.39

Medium Farm	I	RISK MINIMIZING PLANS II	III	IV	V	VI
(a) Return to Fixed Farm Resources (R) (N)	3127.29	3488	4066.77	4617.8	5364.18	5646.5
(b) Minimized Standard Deviation (SD)	1588.47	1222.94	1517.79	1815.95	2258.32	2579.89
(c) Coefficient of Variation of Return (%)	50.79	35.06	37.32	39.32	42.10	45.69

crops occupy more areas. But as we proceed in the expected return - absolute deviation frontier, the concern for risk decreases and for income increases. In the intermediate plans, the concern is for both income and risk; to satisfy higher income level, more areas will be under cultivation with considerable emphasis on high income crops. Similarly to contain risk, less risky crops also occupy significant areas in these plans. In the few last plans, high incomes are expected with least concern for risk. hence high return and high risk crops are selected while low income and low risk crops are eliminated.

Using estimated standard deviation as a measure of risk (variance of returns) under Expected Return - Absolute Deviation (E-A) criterion for each crop enterprise, the risk level of crop enterprises under study were calculated and shown in table 5.7 below. Cowpea appears to be highly risky out of all crops. Mixed crop enterprises especially maize/sorghum/cassava have lower risk than sole crops. However, maize/melon and maize/sorghum enterprises have higher risk than sole yam and maize.

From table 5.6, risk level of plans increased as expected returns increased. Comparing this table with table 5.4 and 5.5, one can infer that less risky crops are incorporated into plans at high hectarages in farm plans with less expected returns. On the other hand, area cultivated under risky crops will increase with expected return. However, this again depends on the trade-off between risk and return for the crop in particular. Using this criterion, one can categorize cowpea, as more risky enterprises while m/s, m/c and sorghum are less risky enterprises for the small farms. Also the cultivation of sorghum and yam are less risky in the medium farm.

Table 5.7: Estimated Risk Level of Enterprise using Expected Return - Absolute Deviation (E-A) Criterion

ENTERPRISE	ESTIMATED* STANDARD DEVIATION	EXPECTED GROSS MARGIN (N)	RISK MEASURE (COEFFICIENT OF VARIATION)
MZE	465.36	894.32	0.52
YAM	323.73	809.02	0.40
CSV	344.71	675.17	0.51
LCP	114.59	134.44	0.85
SGM	75	146.07	0.51
MZE/SGM	474.33	979.01	0.48
MZE/SGM/CSV	615.26	2474.29	0.24
MZE/MEL	448.12	1019.30	0.44
MZE/CSV	466.29	1201.63	0.38

*The Standard Deviation of each is estimated using the formular $\sigma = D. \left[\frac{\pi s}{2(s-1)}\right]^{1/2}$ as earlier defined.

Source: L.P. Output

Generally from tables 5.5 to 5.6 it is observed that cultivated area under mixed cropping patterns is reduced as return and risk increases in plans. The increasing hectarages of m/s/c in plans II to IV could be explained by the fact that its income generating potential is high enough to sufficiently offset the mean absolute income deviation which is minimized in the model. The tables also show that by optimizing and including better crops, farmers can get more returns at the same or even at a lower level of risk than they are presently taking. A one per cent increase in net returns increased risk elasticity of return by 1.642 per cent on the small farm and 0.55 per cent on the medium farm.

An attempt was made to determine the impact of cropping pattern on risk. The model was therefore, run with only sole crops for both small and medium farms at the same level of target return and constraints. The minimized standard deviations of the plans were then compared with the original plans incorporating both mixed and sole crops. Though some of the mixed crops have higher risk than some sole crops, their inclusion in the farm plan reduces the risk associated with the farm plan at each level of return attained when only sole crops were included. As indicated in table 5.8 and figures 5.2 and 5.3 for small and medium farms respectively, the inclusion of sole crops alone in the plan shifted the frontier to the right while the plans incorporating the mixed crops are to the left. These results show the decreased risk associated with more diversified farm plans.

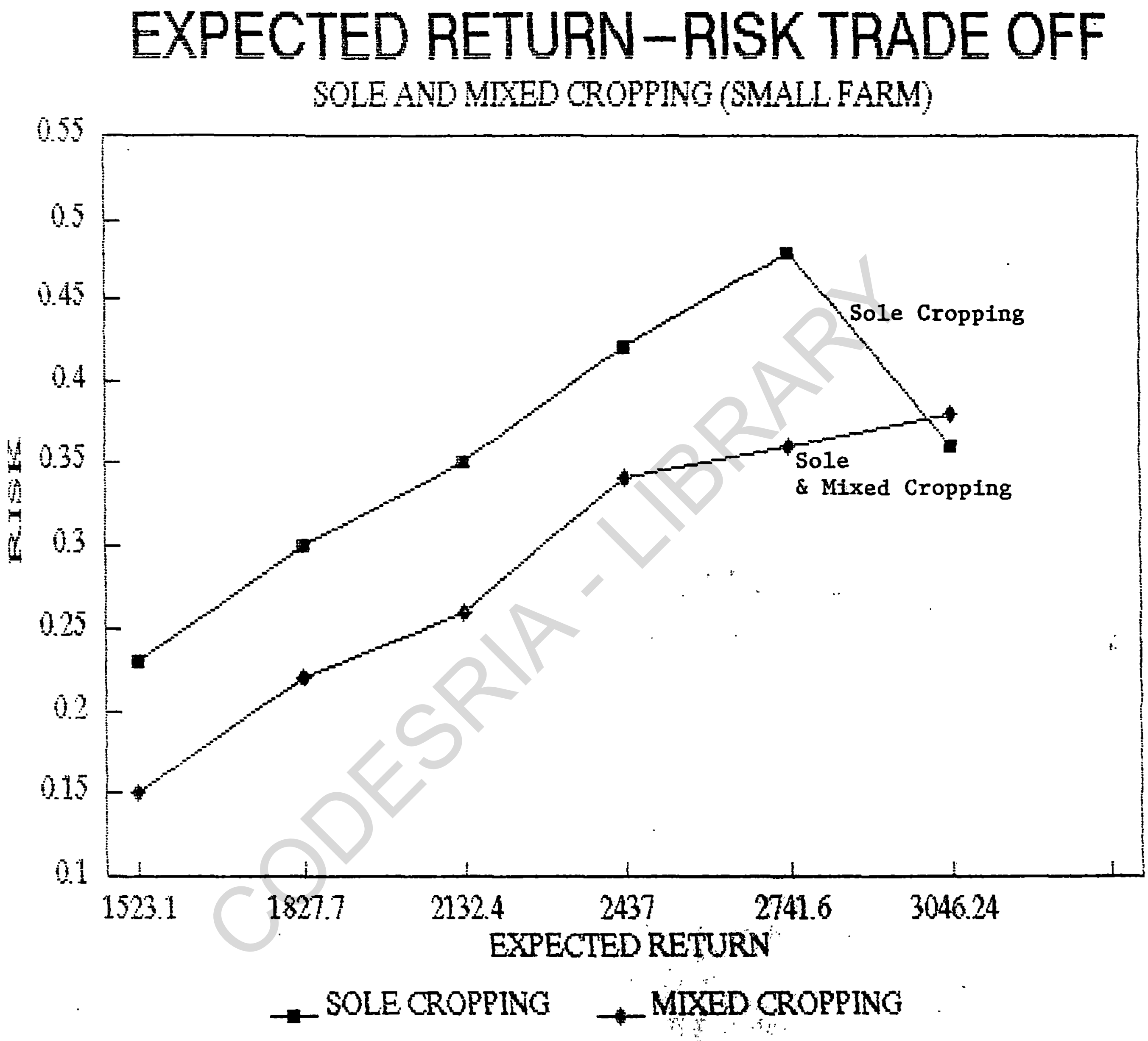


Fig: 3.2: **Efficiency Frontiers of Sole and Mixed Cropping System (Small Farm)**

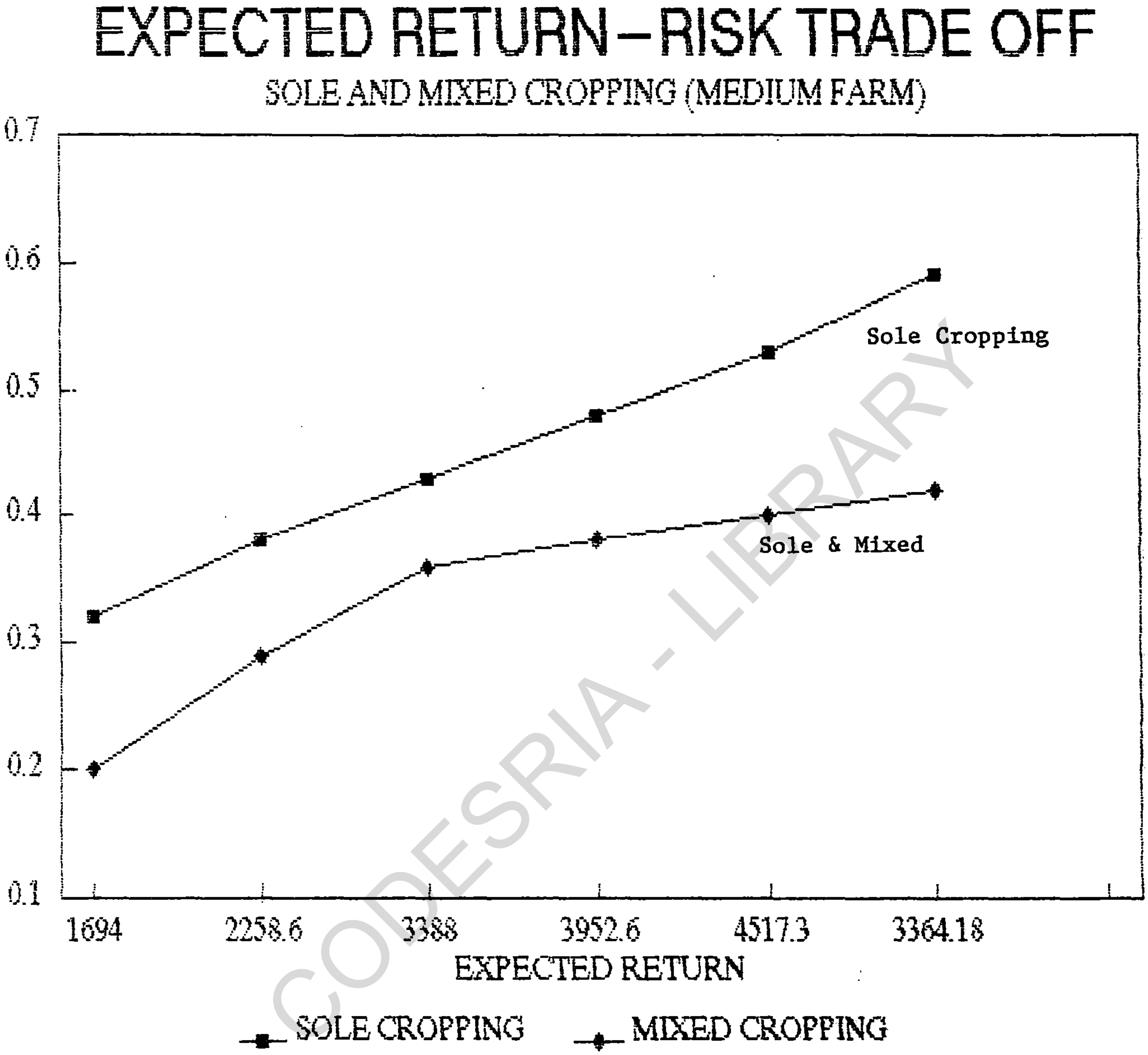


Fig:5.3 : Efficiency Frontiers of Sole and Mixed Cropping System (Medium Farm)

5.3 Trade-off Between Risk and Return

Risk is widely recognised as a key factor in most farm enterprise choice decision problems. The trade-off between returns and income variability provides a key to this decision problem given that the risk attached to profit outcomes affects farmer's decision making. The trade-off is best represented by the coefficient of variation. The trade-off between risk and return is shown in table 5.9 below. It indicates the alternative choice of returns that corresponds to different degrees of risk for both small and medium subsistence farmers.

Table 5.8: Expected Return - Risk Trade-off for Sole and Mixed Cropping Pattern

EXPECTED RETURN (N)	SOLE CROPPING COEFFICIENT OF VARIATION OF NET RETURN OF RISK LEVEL	MIXED CROPPING COEFFICIENT OF VARIATION OF NET RETURN ON RISK LEVEL
SMALL FARM		
1523.1	0.23	0.15
1827.7	0.30	0.22
2422.7	0.35	0.23
2532.5	0.42	0.32
2847.6	0.48	0.34
3046.24	0.56	0.38
MEDIUM FARM		
1694	0.32	0.20
2258.6	0.38	0.29
3488	0.43	0.36
4066.77	0.48	0.37
4617.8	0.53	0.39
5364.18	0.59	0.42

Source: L.P. Output.

It is clear from table 5.7 above and as discussed earlier that cropping pattern has a major impact on risk and returns; the highest return enterprise combination is associated with the highest risk. As crop combination pattern increases, both return and risk decreases. The trade off between risk and return is also captured by the coefficient of variation. As return decreases, the coefficient of variation reduces, indicating that risk per naira of expected return is reduced. The standard deviation of return also decreases; an indication of decreased risk associated with more diversified farm plans.

An observation of the crop enterprises under the plans with the various expected return (table 5.4 and 5.5) indicates the type of trade-off facing farmers in the study area. Gross margin can be increased from N2847.6 to N3046.24 for the small farm by removing sorghum and maize/sorghum enterprises from the plan. For this change, the lower bound of the confidence interval decreases only by N85.2 showing the little increase in risk associated with the change. But the lower bound confidence interval decreases by N219.32 when income is increased from N2422.7 to N2532.5. Therefore, the lower the change in lower bound confidence interval as expected income is increased, the lower the change in Risk accompanying such enterprise combination changes in the farm. Choice can then be made on the basis of this and enterprise combination adjusted accordingly.

Table 5.9: Trade-off Between Expected Return and Risk from E-A Criterion

EXPECTED RETURN (N)	COEFFICIENT OF VARIATION OF NET RETURN OF RISK LEVEL	CONFIDENCE INTERNAL	
		Lower Bound	Upper Bound
SMALL FARM			
1218.5	0.13	912.16	1548.18
1523.1	0.15	1066.2	1980
1827.7	0.22	1017.5	2637.9
2422.7	0.23	1011.48	3253.3
2532.5	0.32	792.16	4081.8
2847.6	0.34	792.16	4691
3046.24	0.38	706.96	5385.5
MEDIUM FARM			
1694	0.20	1010.66	2377.34
2258.6	0.29	948.8	3568.4
3488	0.35	942.12	5833.88
4066.77	0.37	917.02	6988.18
4617.8	0.39	885.4	8149.2
5364.18	0.42	847.54	9880.82

Source: L.P. Output.

5.3.1 Efficiency Frontiers

The efficiency frontiers derived with the risk-return trade off are shown in figures 5.4 and 5.5 below for small and medium farm respectively. An efficiency frontier provides information concerning the trade-off between risk and return

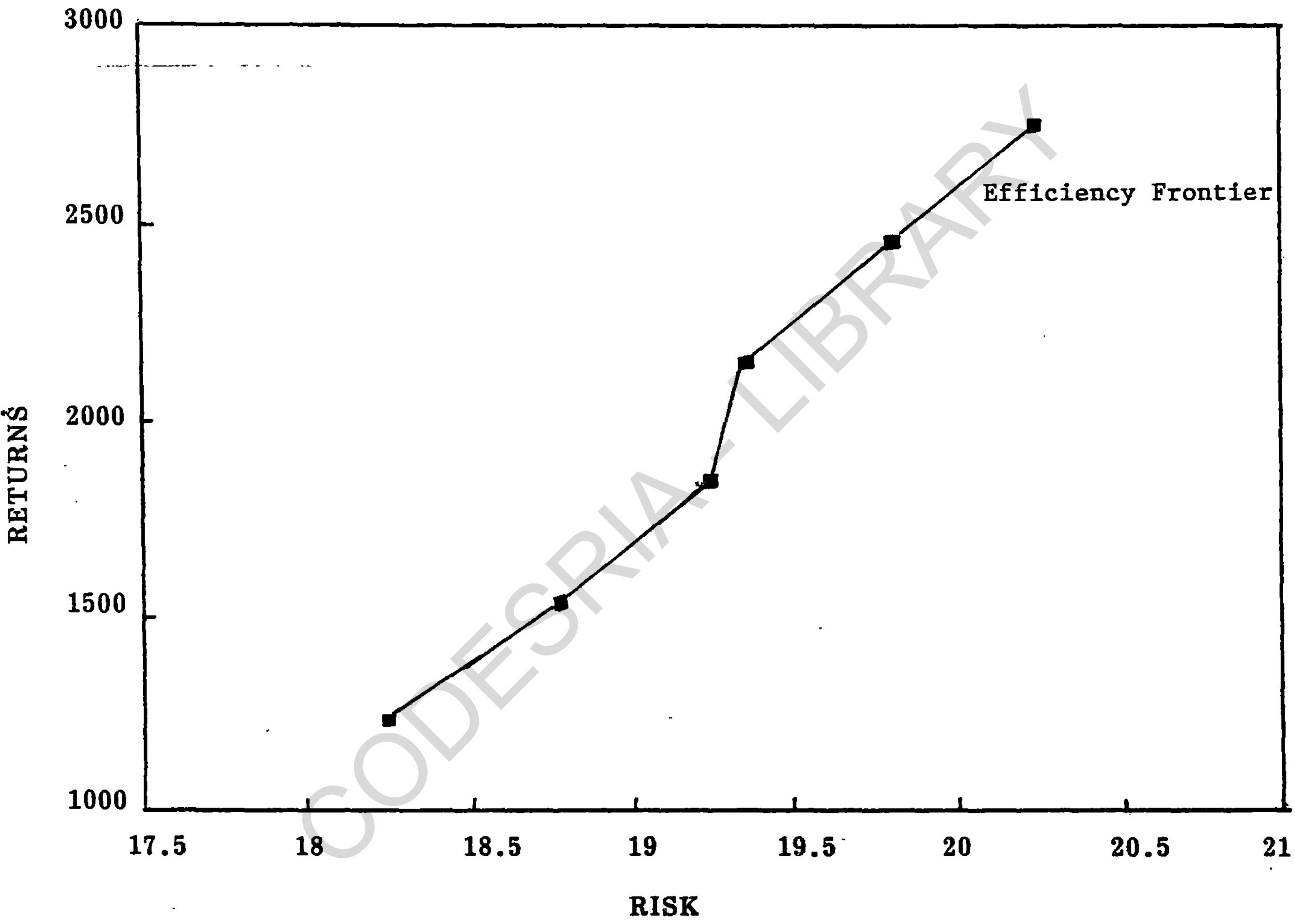


Fig 5.4: Efficiency Frontier of Risk Minimizing Plans for the Small Scale Farm (less than 2.0 ha)

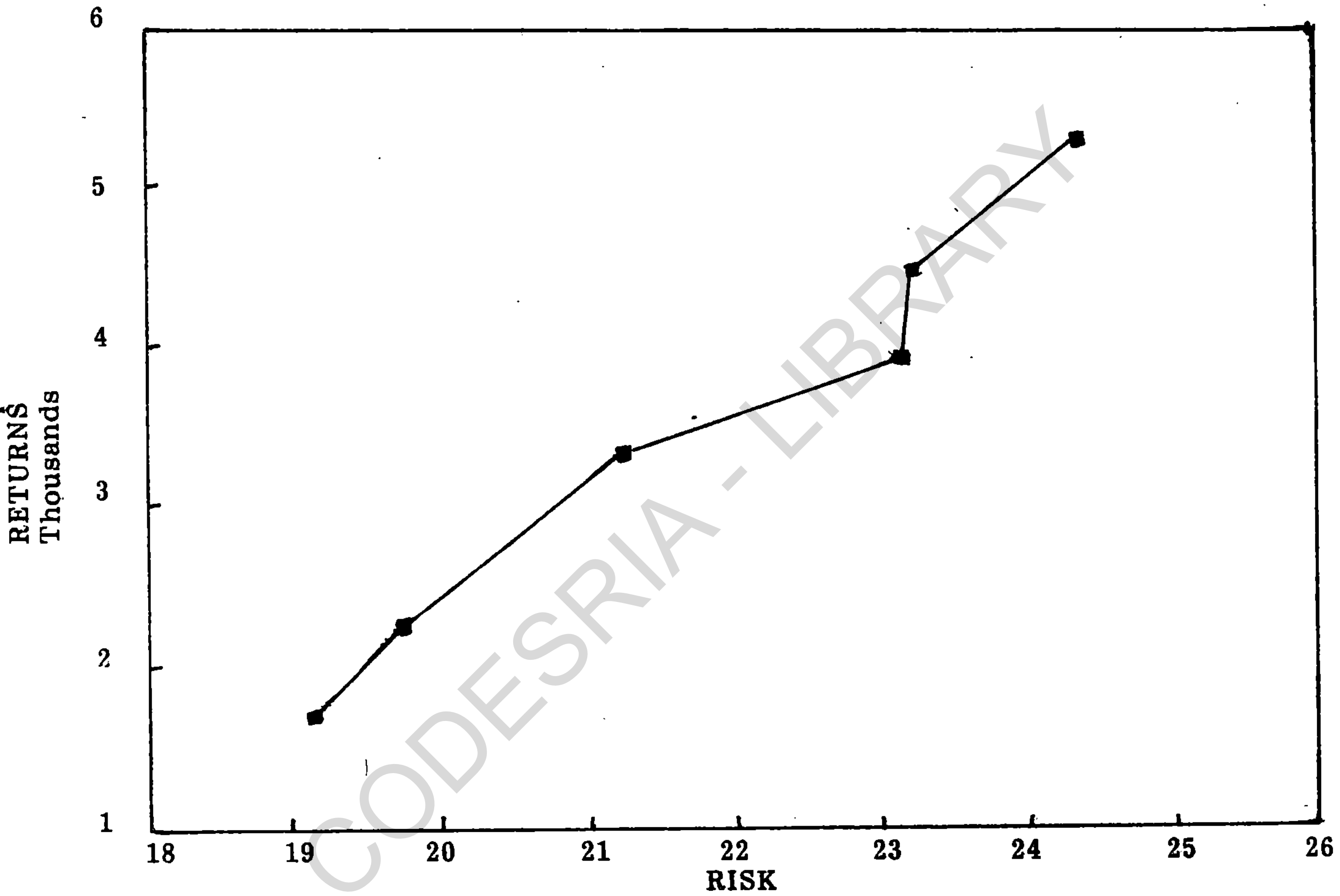


Fig 5.5: Efficiency Frontier of Risk Minimizing Plans for the Medium Scale Farm (2.1-5 ha)

in farm enterprise choice decision. It represents the expansion path for the growth of the farm firm.

The frontier may also be denoted as E-V curve where E represent the expected income and V is the variance of income which is a measure of risk. A movement to the left of the E-V frontier is associated with less risk and lower expected income. It is immediately obvious that the medium farm plans which has included melon production substantially in its optimal plan extended the range of return and risk possibilities confronting the decision maker.

5.4 Sensitivity Analysis

The results discussed in the earlier section identifies one major binding constraint to the operation of the small farmer. This is the credit constraint. Thus the sensitivity analysis of the model was performed with variations of the Credit constraint. This was done by increasing available cash by 50 per cent. This increase represents the maximum obtained by a single farmer in the sample.

5.4.1 Effect of Increasing Credit

Table 5.10 indicates the impact of increasing cash borrowing by fifty per cent on the optimal farm plans. As expected there was increased income and the increase in income was associated with more risk and income variability. However the increase in income is more than offset by the increase in standard deviation. Thus the relative variability measure remain almost the same. Yam and melon cultivation increased marginally in these plans while the cultivation of m/s/c and cowpea reduced. The efficiency frontiers (fig. 5.6 and 5.7) produced by these plans for small and medium farms also show a higher risk efficiency than the original model. Also the range of return and risk possibilities confronting the producer is extended.

Table 5.10: Sensitivity Analysis with a 50% Increase in base Credit Availability of Credit Constraint on Small and Medium Farms

Derived Plans	II	III	IV	V	VI	VII
Small Farm						
Expected Return Gross Margin ₦	1239.6	1622.32	2035.4	2360.4	2938.2	3041.6
Standard Deviation ₦	156.06	238.8	410.95	628.82	965.19	1074.2
Coefficient of Variation	12.59	14.72	20.19	26.64	32.35	35.32
Medium Farm						
(a) Return to Fixed Farm REsources	1762.3	2462.7	3732.42	4212.8	4620.82	5472.34
(b) Standard Deviation	358.09	731.91	1422.79	1799.7	1992.03	2392.50
(c) Coefficient of Variation	20.32	29.72	38.12	42.72	43.11	43.72

Source: L. P. Computer Output

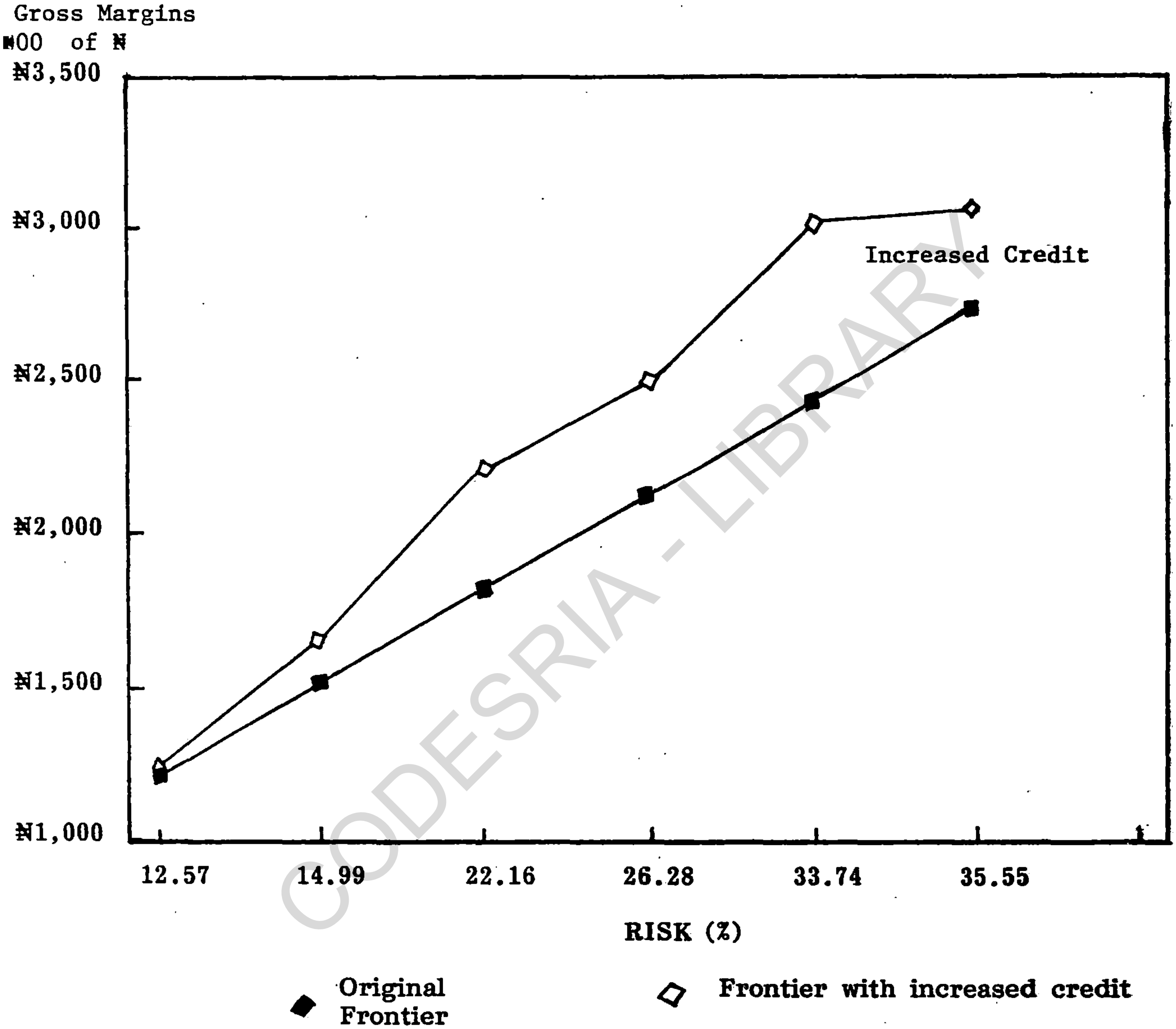


Fig: 5.6 : Sensitivity Analysis: Efficiency Frontier of Risk Minimizing Plans with Increased Credit (Small Farm)

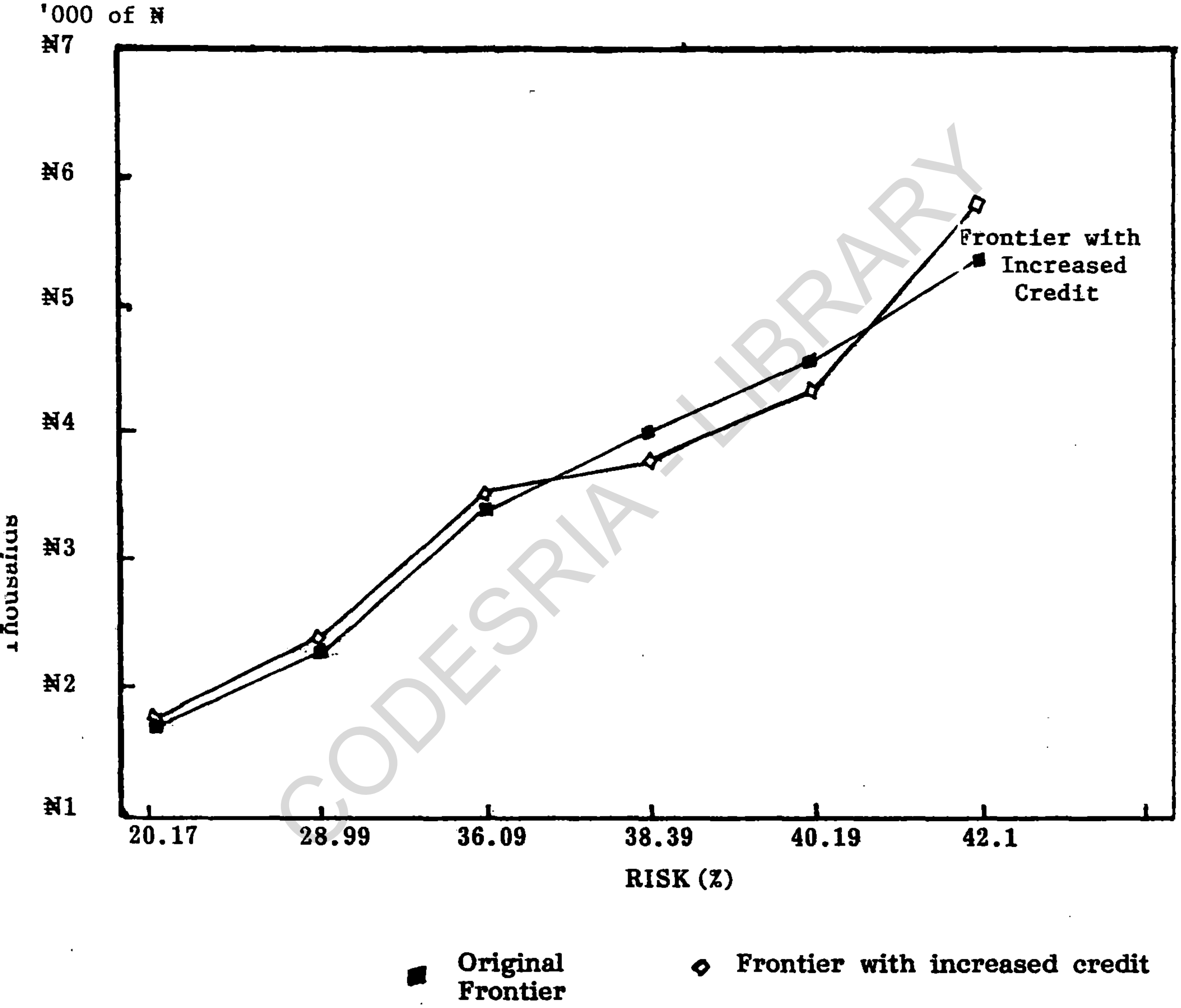


Fig: 5.7 : Sensitivity Analysis: Efficiency Frontier of Risk Minimizing Plans with increased credit (Medium Farm)

CHAPTER VI

ELICITED RISK ATTITUDES AND FARMERS ATTRIBUTES

6.1 Farmers Subjective Perception of Risk and Uncertainties

There is a growing awareness in risk management studies of the importance of eliciting the perception of risk from the farmers individual subjective judgements (Collender 1989). On-farm testing is increasingly emphasized so that perceptions converge more rapidly on the expected profitability of crops under farmers agroclimate and socio-economic condition.

Therefore, if risk perceptions markedly condition farmers behaviour, it becomes imperative to know what they perceive as source of risk. It is also important to understand how their perceptions are formed and changed, their traditional methods of avoiding risks and perceived ways of ensuring a favourable trade-off between returns and risk. This often presents a complex problem as most methodological approaches use a game setting which is often inadequate as it does not represent actual behaviour in real life. An attempt is made here in a simple analytical way through ranking to elicit farmers subjective judgement of risk in crop production. Toward this end, farmers were asked to identify what they consider as risk situation on the farm and eventually to classify crops according to the degree of risk involved in their cultivation.

Farmers perceived weather as the most risky variable affecting farm operations irrespective of the crops under cultivation. This reflects in yield variations of the crops over years. The small farmer therefore relies greatly on his knowledge of the expected average yield and its probability distribution as reflected by the corresponding variability. Low levels of income/output make him more determined to produce for "survival" purpose, this factor therefore influences his decision most.

Farmers in the study area reported production risk in terms of causes of either crop failure or constraints to overall production. Crop failures due to bad weather (drought or too much rain), lack of fertilizers at critical periods, disease and pest attacks, erosion, soil type, untimely planting due to poor rain forecasting and lack of capital were all reported as forms of risk. Poor health as it affects performance on the farm and seasonal labour bottlenecks were similarly classified. Crop diversification, crop rotation, shifting cultivation, fallowing, mixed cropping and timely planting were mentioned as risk aversion measures.

Crop diversification ensures that at least, some of the crops are able to survive the various forms of hazzards. Crop rotation on the other hand also ensured both a distributed supply of food throughout the year and an even use of labour inputs. This then reduces the pressure on labour peak periods. Fallowing though reduces the land under cultivation, replenishes soil fertility with time while mixed cropping ensures survival of at least one crop in case of bad weather, pest and disease attacks. Surprisingly, fallowing was especially perceived as a good strategy as it was noted that fertilizers are often hard to obtain and non-utilization of the right quantity rapidly accelerates growth of weeds which results in more labour cost.

The state Government, in order to reduce the level of risk according to these farmers could offer more technical assistance to the farmers. This is in form of soil test, irrigation, provision of credit, timely distribution of seeds and fertilizers and supply of accurate information on rainfall. Farmers need to be educated on farm operations and the advantages of better crop technologies. The farmers favour establishment of farmers market which should be backed by a good marketing policy.

On individual crop basis, the farmers felt that the possibility of planting maize twice in a year overshadows the risk inherent in its cultivation. Water requirement at its initial growth period is critical for the crop's survival. The susceptibility of cowpea to pest and diseases makes it more risky to cultivate and the prevention and control of diseases demand much money than they could afford. Melon production is not considered risky in terms of tendering during cultivation but it takes much space and often gives low yield. Yam is mostly planted in the study area, yet the farmers consider its need for labour especially during staking and ridging very critical. Thus, non availability of labour for yam at the right time may lower yield appreciably. Cassava production is considered less risky, less expensive to manage and less susceptible to pests and diseases when compared to most crops. It is mostly planted as a security against bad harvest from other crops. Therefore, it is preferably planted mixed with other crops by these small farmers.

Given full considerations of the above highlighted elements of risk in crop production identified by farmers, the latter were asked to classify crops subjectively according to their perceived risk level. From the collected data, only farmers with up to seven years or more experience in farming were incorporated in the analysis so as to get a subjective classification based on years of experience. 158 data points were analysed and the cultivation of five major crops; maize, cowpea, sorghum, melon and yam were considered risky by the farmers in varying degrees. The percentage subjective categorization of each crop is shown in table 6.1. The table presents the percentage distribution of the responses for each crop. 57 per cent of respondent considered maize as highly risky while yam was considered highly risky by about 52 per cent of the respondents. Sorghum could be considered of medium risk as about 45 per cent respondents classified it in this category.

Table 6.1: The Percentage of Farmers that accord Cultivation of Specified Crops varying degrees of risk

Percent (%)

Crop	Very High Risk	High Risk	Medium Risk	Low Risk	Very Low Risk	Total
MZE	57	25.9	14.6	0.6	1.9	100
YAM	52	30.0	12.0	6.0	-	100
SGM	16.1	16.1	45.2	16.1	6.5	100
MEL	12.5	12.5	25.0	37.5	12.5	100
LCP	72.7	18.9	6.8	1.5	-	100

Source: Field Survey Data, 1989/90.

Melon was adjudged to be of low risk while cowpea was considered highly risky. The latter was ascertained by almost 73 per cent of the respondents. Further analysis of the highly risky classified category through RUNS test which is a non-parametric analysis shows the various probability at which the farmers' considered judgement of each crop as being highly risky is significantly different from the farmers' other specifications and average specification in all categories for each crop. The results shown in table 6.2 highlighted maize and cowpea as highly risky making this judgement to be significantly different from the estimated average of all other specified risk levels.

Table 6.2: Runs Test of Highly Classified Crops

Crop	Cases		Test Value	Z Value	2-Tailed Probability
	Arithmetic Mean	Geo-metric Mean			
MZE	90	68	1.67	-2.36	.02
YAM	26	24	1.72	-1.13	.26
SGM	10	21	2.81	-.86	.39
MEL	4	4	3.25	1.14	.25
lcp	96	36	1.39	-2.73	.006

Source: Field Survey Data.

6.2 Relationship Between Estimated Risk Coefficients and Farmers Attributes

This study hypothesized that risk-income preferences of farmers vary with their characteristics and socio-economic environment. Risk coefficients were therefore elicited for farmers and related to their socio-economic background and environment where they live. The farmers utilized for this purpose were those that have had up to 7 years or more experience in farming. It is expected that their past experience would have influenced their decision to operate their present plan. Using the standard deviation as a measure of risk, and utilizing the estimated risk level of enterprises using E-A criterion, measures were derived for the individual farmer's existing plan based on hectarages grown for each crop. These were then related to the socio-economic variables of the farmers through a stepwise regression model.

Three classes of variables were used to define the socio-economic characteristics of the peasant households in the study area. The first class of variables was related to the nature of the Household head. These variables included Age, Farming Years, Education and Family size. The second set of variables represented the income generating opportunities of the peasant household and included cropped area, level of off-farm income, farm income, number of workers in the family and the quadratic form of the cropped area. The third set of variables which defined access of the farmers to formal and informal institutions were represented by membership of community association, loan procurement and whether a selected farmer is an ADP contact farmer or not.

Four functional forms; linear, semi-log, Double log and Exponential were fitted to the data and the best functional forms in terms of R^2, t-ratio, significance of the coefficients and standard error of estimate were picked for regression explanations. The results of the various functional forms are presented in Appendix 20 to 35.

In order to ascertain the relative importance of the above class of variables in terms of contribution to the variation in risk levels of the farmers, separate stepwise regressions were performed for each class of variables before combining them to determine the relative impact on risk due to interactions.

Table 6.3 presents the stepwise regression result with variables representing the nature of the farmers household. The variables accounted for up to 72 per cent variation in risk coefficients. Age appears to be the overriding factor in risk consideration followed by experience of farmers in farming, family size and education. Positive

coefficients indicate greater risk as the variable increases and vice versa.

The second set of variables representing the income generating opportunities of the farmers accounted for about 56 per cent variation in risk among the farmers. This is shown in Table 6.4. The number of workers in the family is the most

Table 6.3 : **Regression Result with of Estimated Risk Coefficients with Variables Representing Nature of the Farmers Household**

Steps	Age	Farming Years	Family Size	Education	R^2 (Adjusted)	F	Intercept	Std. Error of Estimate
1	-.006** (-4.87)				.65	23.7	-.22	.066
2	-.004** (-2.64)	-.004 (-1.35)			.67	13.06	-.28	.065
3	-.002** (-1.83)	-.004 (1.53)	-.006 (-1.31)		.69	9.48	-.29	.064
4.	-001** (-1.73)	-.005** (-1.92)	-.007 (-1.53)	-.003 (-1.27)	.70	7.65	-.28	.063

(t - ratio are in parenthesis)

**Significant at .05 level

Source: Field Survey Data, 1989/90

Table 6.4: **Regression Results of the Estimated Risk Coefficients with Variables Representing Income Generating Potential of Farmers**

Steps	Number of Workers in Family	Cropped Area	Off-farm Income	Farm Income	Square of Cropped Area	R^2 (Adjusted)	F	Intercept	Std. Error of Estimate
1	-.02** (-2.57)					.41	6.62**	.38	.06
2	-.017** (-2.16)	.008 (1.33)				.46	4.27**	.35	.06
3	-.017** (-2.31)	.013 (2.12)**	.154 (2.00)* *			.56	4.46**	.29	.06
4	-.018** (-2.33)	.012* (1.82)	.157* * (2.02)	.549 (.63)		.56	3.37**	.29	.06
5.	-.018** (-2.29)	.013* (1.94)	.154* * (1.83)	.573 (.63)	-.200 (-.11)	.56	2.61**	.29	.06

Source: Field Survey Data Regression Results.

**Significant at .05 level

important factor followed by the cropped area, off-farm income, farm income and quadratic form of cropped area. For the third set of variables highlighted in Table 6.5 which also significantly contributed to risk coefficient variations among farmers, experience as ADP contact farmer is the most important factor though not significant. Ability to procure loan and membership of community association follow in order of priority.

Table 6.6 highlights the results of stepwise regression incorporating all the socio-economic variables that might influence farmers risk behaviour in crop production. This result has therefore incorporated interactions among all the variables.

6.2.1 Relation of Elicited Risk Coefficients to the Nature of the Farmers Household

A priori, other things being equal, it is expected that older farmers should be less willing to take risk than the younger ones. This should be particularly true in subsistence agriculture where age can hardly imply more experience on the job. The data supports this assertion and age was negatively correlated with risk taking disposition. This was also the

Table 6.5: **Regression Results of the Estimated Risk Coefficients of Farmers with Variables Representing Access to Institutions**

Steps	No. of Years as ADP Contact Farmer	Amount of Loan	Membership of (b) Comm. Association	R^2 (Adjusted)	F	Intercept	Std. Error of Estimate
1	-.015 (-0.046)**			.49	10.6**	.36	.06
2	-.019 (-0.007)**	.032 (.036)		.52	5.66**	.36	.06
3.	-.02 (0.007)	.03 (.042)	.002 (.05)	.51	3.65**	.36	.06

**Significant at .05 level

(Standard errors are in parenthesis)

(a) Loan procurement is coded as 1 if farmer obtain loan for farming and 0 otherwise

(b) Membership of community association is coded as 1 if farmer belong to a community association and 0 otherwise.

Source: Field Survey Data, 1989/90

Table 6.6 : Regression Result of the Estimated Risk Coefficients with Farmers' Socio-economic Variables (Linear Functional Form)

Steps	Age	Farm Income	Family Size	Off-Farm Income	Farming Years	Amount of Loan (₦)	Cropped Area	Loan Procurement	Membership of Comm. Ass.	Years as ADP Contact Farmer	Cropped Intensity	No. of Workers in Family	Education	R^2 (Adjusted)	F	Intercept	St. Error of Estimate
1.	-.004*** (-5.02)													.66	25.16	.55	.05
2.	-.005*** (-5.57)	.144** (2.13)												.71	16.25**	.52	.05
3.	-.004*** (-4.41)	.148** (2.29)	-.004 (-1.71)											.73	11.47**	.52	.05
4.	-.004*** (-4.45)	.164** (2.39)	-.004* (-1.74)	.647 (1.12)										.74	9.0**	.50	.05
5.	-.003* (-1.73)	.162** (2.38)	-.004* (-1.88)	.648 (1.13)	-.002 (-1.12)									.76	7.51**	.47	.05
6.	-.003 (-1.55)	.159** (2.33)	-.004 (-1.29)	.478* (1.78)	-.002 (-1.22)	-.516 (-.84)								.76	6.31**	.47	.05
7.	-.002 (-1.22)	.129 (1.74)	-.004* (-1.92	.741* (1.73)	-.003 (-1.31)	-.696 (-1.09)	.006 (1.06)							.78	5.60**	.43	.05
8.	-.003 (-1.51)	.155 (1.95)*	-.004* (-1.89)	.918* (1.84)	-.002 (-1.05)	-.995 (-1.39)	.006 (.99)	.024 (.92)						.78	4.98**	.44	.05
9.	-.003 (-1.32)	.176 (2.23)	-.005 (-1.31)	.123* (1.74)	-.003 (-1.37)	-.859 (-1.21)	.005 (.86)	.06 (1.68)	-.045 (-1.43)					.80	4.84**	.43	.05
10.	-.002 (-1.09)	.154* (1.89)	-.004* (-1.99)	.114 (1.63)	-.003 (-1.37)	-758 (-1.05)	.006 (1.03)	.073* (1.92)	-.037 (-1.19)	-.007 (-1.03)				.81	4.47**	.41	.05
11.	-.002* (-1.71)	.153* (1.83)	-.004* (-1.97)	.112* (1.72)	-.003 (-1.37)	-.828 (-1.08)	.006 (1.03)	.08* (1.91)	-.042 (-1.13)	-.006 (-.87)	-.015 (-.31)			.81	3.91**	.43	.05
12.	-.002* (-1.92)	.153 (1.78)*	-.003* (-1.86)	.116* (1.70)	-.003 (-1.27)	-.866 (-1.07)	.006 (1.01)	.074* (1.83)	-.049 (-.96)	-.006 (-.79)	-.015 (-.30)	-.002 (-.19)		.81	3.43**	.43	.05
13.	-.002* (-1.86)	.149* (1.88)	-.002* (-1.87)	.117* (1.70)	-.003 (-1.18)	-.709 (-.60)	.006 (.88)	.076* (1.76)	-.039 (-1.94)	-.006 (-.78)	-.019 (-.34)	-.002 (-.20)	-.692 (-.18)	.81	3.03**	.44	.05

case with farming experience and it appears that ability to take risk under subsistence conditions does not require a lot of experience.

Two different interpretations can be given to the relationships between risk taking and family size. One is that, the larger the family size, the higher the subsistence consumption needs and given a fixed amount of land, the lower the willingness of the farmer to take risks. In this case, family size reflects the consumption needs of family members. On the other hand, a larger family indicates greater availability of labour on the farm which is particularly important at harvest time when there is usually labour shortage and a greater capacity to generate off-farm income. As a result, the capacity of the farmer to assume risks increases with family size. The data supports the earlier interpretation; large family size tends to decrease the farmers ability to take risk. This may mean that less of the farmers household members are engaged in off-farm production activities. On further analysis, it was discovered as highlighted in chapter 4, that members of the farmers household are mostly children whose burden of school fees may have contributed to the farmers risk averseness. The average family size is about 6 with up to 61.5 per cent of the farmers having above 6 children.

Higher levels of education have generally been associated positively with risk taking. In the study area, the average number of years of schooling is quite low (3.69) indicating the attendance of primary school only and very few farmers went above this. This low level of education may be responsible for the negative impact of schooling on risk taking though not significant in the regression results. In fact, it comes least among the influencing factors in order of priority.

6.2.2 Relation of Elicited Risk Coefficients to Income Generating Opportunities of Farmers Household

Farm income and off-farm income of farmers have positive impact on risk taking ability of the farmers. The higher the level of these incomes, the higher the capacity of the farmers to assume risks in agricultural production. These two factors as a result of interactions with other factors tend to influence risk behaviour more prominently than the number of workers in the farmers household (as earlier indicated in table 6.5). The number of workers in farmers family have a negative impact on risk which indicates that income earned by those workers do not significantly influence his decision on the farm. Therefore, the income from these workers may not have helped to reduce his family burden and responsibilities. Also it could not have been much as members of the family are mostly children who still go to school.

The cropped area have a positive impact on farmers ability to take risk. This is consistent with both Pratt and Arrows formulation of decreasing absolute risk aversion for increasing wealth (if possession of land is taken as a measure of wealth for the farmers) as well as Walkers (1985), Foster and Rauser (1991) findings regarding peasant risk aversion. Following the logic of safety first, this becomes less effective as income rises beyond subsistence requirement. Thus, as more area are brought into cultivation, (as represented by the cropped intensity variable in table 7.8) the impact of land on risk taking becomes negative.

6.2.3 Relation of Elicited Risk Coefficients to Farmers Access to Formal and Informal Institutions

Credit use (amount of loan) had a negative impact on risk taking ability as shown in table 6.6. The more the loan farmers obtain from formal and informal associations, the less willing they are to take risk. This is not in agreement with Olomola, 1989, findings on credit use in traditional farming where credit was highlighted to improve farmers ability to take risk and therefore to adopt new technology. However, the sign of loan procurement (dummy variable) coefficient is positive and significant showing that a change from farmers with no access to loan or who do not obtain loan to farmers who obtained loan is characterized by an upward shift in the level of risk taking.

There can only be two interpretations for these observations. One is that a farmer's access to loan increases his confidence at taking risk as the loan tends to serve as security against risk. Secondly, it appears that very little of the procured loan is actually spent on the farm as the amount obtained has negative impact on risk taking disposition.

It is surprising and interesting that experience of a farmer as ADP contact agent and his belonging to a community association have negative impact on his risk taking ability. The regression results with variables representing nature of farmer household earlier shown in table 6.3 indicated a positive influence of membership of community association on risk. But the interaction of other factors have made it's effect negative in table 6.6. Apriori, one expects these two variables to influence farmers ability to take risks positively. This result may be an indication that the extension work is not having much impact as regards influencing the farmers risk behaviour. This showed vividly in the remarkable difference between farmers existing plan and the risk efficient plans. It also indicates to some extent the little impact of the community associations in assisting production decision and assisting farmers to follow technological recommendations. Further analysis reveals that most of these community associations are farmers youth clubs and thrift and credit cooperatives. Most of them engage in assisting farmers to procure loans. The usual community associations that assist in farmers farm operation like "Aro" are less prominent. Perhaps then, the effective community association would be marketing cooperatives and more of production cooperatives that will introduce the extended recommendations to the farmers.

The foregoing discussions support the assertion that risk-bearing capacity of peasant farmers can be explained by their socio-economic characteristic and structural characteristics. Particularly significant for this purpose are the Age of farmers, farm income, family size, off-farm income and loan procurement by farmers.

CHAPTER VII

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 Summary of Major Findings

This study explore the optimum combination of enterprises under risk for the small farmers. It sought to identify socio-economic variables responsible for the farmers' attitude toward risk. Specific objectives of the study included working out optimum combination of crops under risk, examining attitudes toward risk for the farmers and relating these to the socio-economic characteristics of the farmers' household. This was accomplished through using a Target-MOTAD model and regression analysis.

Primary data were generated from a field survey of the Agricultural Development Project (ADP) farmers in the Northern part of Oyo State while secondary data were extracted from the historical records (Agronomic surveys) of the defunct Oyo North ADP (ONADEP) at Saki, Oyo State. The risk and the socioeconomic characteristics that may affect attitudes to risk. Since technologies have inherent risk and uncertainties, farmers attitudes to risk in their environment determine the rate of adoption of innovations and technologies. Moreover, several farm management studies have always assumed profit maximization objectives for the small farmer in order to determine optimum combination of enterprises, given limited productive resources. However, consideration of many goals in the farmers choice-basket influences his decision which makes his resource allocation deviates from profit maximization principle.

The theoretical framework for the analysis derives from the mean-variance efficiency criteria under safety first rule. This approach usually assumes that the decision maker maximizes expected utility. Thus, his preference among alternative farm plans is expressed in terms of expected income and associated variance.

Historical time series data for yields, prices and cost of production provided the basis for calculating the expected returns associated with each production activity. The time series data extended over the period 1983/84-1988/89. The producers were assumed to base their plans on the long-term mean of returns and any deviation from this mean is regarded as a random event. The series of Gross Margins were deflated using a GDP deflator to reflect 1989 constant prices.

Under the safety first criterion, which assumes family survival instinct, the study determines a set of risk minimizing efficient plans for small and medium farms. Small farms range between 0.1 - 2 hectares while the medium farms are from 2.01 - 5 hectares. The study presents and compares; the farmers existing plan, which was the average of farmers production plan for size categories; the profit maximization plan which determines the highest attainable point on the efficiency frontier; and the set of risk minimizing plans derived by parameterizing the Total Absolute Deviation of Returns for the model.

The profit maximization plan predicts that the cropping pattern should include 0.27 hectares of yam, 0.09 hectares of cowpea and 0.85 hectares of m/s/c for the small farm. The maximum attainable income for the small farm is N3,046.24 while that of the medium farm is N5,646.5 with 0.43 hectares of yam, 0.53 hectares of cowpea, 0.52 hectares of melon and 1.84 hectares of m/s/c. With the movement from profit maximization plan to risk minimized plans, the concern for risk increases and for income decreases. Therefore, risk increases as income increases in the plans. From the existing plan, farmers are operating at a high level of risk which is 56.32 per cent for small farm and 50.79 for medium farms. This high levels can be reduced with the risk minimized plans and this may possibly increase income too.

One resource was limiting in the analysis. This is the Credit constraint. Sensitivity analysis with this resource shows an extension of the range of risk-return possibilities available to the decision maker. With the relaxation of the constraint, return increases and an increased return correlates with less risk. Thus, an increase in credit reduces risk and increases income.

Evidence from the survey indicates that farmers considered production risks in terms of weather variation and failure of individual crops. The study confirms the assertion of the safety first rule of survival consideration in peasant farming. This shows the appropriateness of the model utilized for the study. Mixed cropping system is largely practised and cropping intensity on the peasant farms is quite high.

Despite this practice, the measure of risk level indicates that the farmers are still operating at a higher risk level than the optimal farm plan under profit maximization as shown in table 5.6.

Sole cowpea was identified as the most risky enterprise while planting mixed crops lowers risk considerably. It was shown that by optimizing and including better crops, farmers can get more returns at the same or even a lower level of risk than they are presently taking.

The study shows a positive trade-off between Risk and Return. Risk levels of farm plans increase as expected returns increase. Actually a 1 per cent increase in net returns increases risk net return elasticity by 1.642 per cent on farms that are less than 2 ha. and 0.55 per cent on the farms between 2.1 and 5 ha. It therefore implies that the net return elasticity risk decreases with size of farms. It is also possible that farmers with big farms have other sources of income. The results also indicate that inclusion of mixed crop enterprises in farm plan reduce risk associated with each plan. As crop combination pattern increases, both expected returns and risk decreases. Furthermore, as farm size increases, the risk minimizing optimal plans extended the range of return and risk possibility confronting the decision makers.

The present level of income of farmers cultivating less than 2 ha. can be increased at a reduced risk level by reducing areas for sole maize, sole cassava and maize/melon enterprises on their farm. Maize and cassava should also be planted mixed with sorghum at increased hectarages. The cultivation of maize/cassava should be reduced by between 47.5 to 70 per cent while that of yam should be increased by 80 per cent. The cultivation of maize/sorghum/cassava should also be increased by between 41 per cent and 76 per cent while maize/sorghum combination should be cultivated in higher hectarages than the present.

For farm between 2.0-5 ha, the study indicated that income can be increased in these farms and risk reduced considerably by up to between 10 and 30.62 per cent if areas cultivated under local cowpea, sole maize, maize/sorghum, maize/cassava and sole cassava enterprises are reduced on the farm and substituted with more areas under yam, maize/sorghum/cassava and maize/melon enterprises. Also the cultivation of sole sorghum should be decreased by between 9 to 56 per cent while melon, maize/melon and cowpea cultivation should be doubled or tripled and yam increased by about 43 per cent.

Five socio-economic variables were identified to be particularly significant in influencing the farmers risk behaviour and decision in the following order: Age, Farm Income, Family Size, Off-farm Income and Loan procurement.

Level of risk taking was found to decrease with increase in Age and Family size while it increases with increases in farm income, off-farm income and ability to procure loan or repayment capability. Other factors found to be negatively related with risk taking ability of the farmers are experience in farming, the amount of loan taken, membership of community association, experience as ADP contact farmer, cropped intensity, number of workers in farmers family and the education level. Also the cropped area was found to be positively correlated to risk level of farms.

7.2 Conclusions of the Study

From the analysis carried out and the field study conducted, it is evident that though peasant farmers try to avoid taking risks especially in the adoption of new technology, their chosen farm plan, due to lack of information on stability of crop enterprises, is in fact adjudged to be riskier than the profit maximizing plan when all costs of risk are taken into consideration under safety first principle. Therefore the problem of the small farmers' attitude is not the ability to take risk but the lack of information about opportunities and constraints which will allow them to take better decisions given their stated objectives. This points to the need for policies that will reduce uncertainties by increasing information about opportunities available to the farmers and their access to resources.

This study has also pointed out the likely relationship existing between socio-economic characteristics and risk attitudes of farmers. The fact that this correlation exists may indicate that, apart from the expected behaviour of the farmers on the basis of economic reasoning and rationality as influenced by economic variables such as prices and other incentives, there exists a part of risk taking behaviour which is inherent to individuals resulting from his environment. This aspect which may be referred to as "preferential risk attitude" varies among farmers and contributes to farmers attitudes toward new technology.

7.3 Policy Recommendations

From the results obtained in this study, the following policy measures are recommended:

(1) There should be a concerted effort by government to increase farm income and reduce variability in returns by exploring various means of minimizing risk on the farm. Toward this end, crop insurance scheme may be instituted for the farmers to cover all crops.
Nigerian Agricultural Insurance Corporation (NAIC) should be made more functional for the small farmers.

(2) It is recommended that low-cost storage methods for various crops be introduced into the study area. This will minimize the impact of low prices at harvest period and the rush to dispose-off produce at this period.

(3) Given that the use of credit on the farm reduces risk, a concerted effort should be made by government to facilitate access of small farmers to small scale credits of Nigerian Agricultural and Cooperative Bank (NACB) and Cooperative Federation of Nigeria (CFN) without the usual demand of a substantive collateral. The government can stand as collateral for these farmers who should be organized into Unions or Cooperatives.

(4) Emanating from the study is the need to group the farmers into societies, unions or cooperatives. This will facilitate positive interactions especially on risk sharing. This will present a collective bargaining front, and serve as a conduit for transmitting government extension recommendations to the farmers.

(5) The extension service should be made more effective. The study has highlighted the importance of information on hedging for risk on the farm. The extension services should therefore be strengthened in terms of personnels, education and material needs.

(6) Given the low possibility of expanding farm size in the study area, it is recommended that yield increasing methods be emphasized in the study area. Therefore continous use of improved varieties of seeds, fertilizer and insecticides should be encouraged.

7.4 Limitations of the Study

There are numbers of limitations to this study. The results obtained should be viewed within the context of the types of data used and the models constructed. It covers only ADP farmers due to possibility of obtaining historical records. It therefore follows that the results apply only to ADP farmers. The first limitation emanates from the scarcity of detailed and reliable information at the farm level. Much reliance is placed on farmers memory and the inability of the farmers to keep records of farm activities complicates the problem. Scanty Data has also limited the explicit analysis of mechanization effects to alleviate labour scarcity problems at critical periods. This is because on non-availability of data about input-output coefficient on mechanization for individual farms.

Secondly, it is doubtful whether an expectation model which measures risk as the deviation from the mean of net returns for a series of years is a reliable measure. Weighted moving average models may be theoretically better for evaluating risk based on long series of historical data. However, the choice of appropriate weights for computing moving average is still an empirical limitation. More research is needed to resolve the questions of how farmers perceive risk and what measure of risk is appropriate in farm planning models.

Another limitation relates to the use of aggregate data on yields, prices and costs in deriving net returns. This aggregation may have a downward bias on the estimated standard deviation since aggregation itself averages out part of the variability. Therefore efforts should be made to collect and record farm-level time series data for future use in risk analysis.

7.5 Suggestion for Future Studies

The importance of Risk in farmers' decision making behaviour is not in doubt but this study has pointed out the need for further studies to distinctly separate the two major factors responsible for the different cropping patterns among farmers; these are the risk attitudes and the resource constraints. The separation of these two factors demand modifications to the specification of the objective functions and constraints in the target-MOTAD model. Another necessity for the conceptual understanding of decision making behaviours under uncertainty is the streamlining of all methodologies of eliciting risk attitudes of farmers. There is need to conduct a research into all these subjective and objective variables and determine their prediction of farmers' risk behaviour. Thus further studies are needed to resolve the questions of how farmers perceive risk and what measure of risk is appropriate in farm planning models. This attempt might lead to appropriate methodology for identifying attitudinal behaviour of the farmers to each technology introduced into an area. Furthermore, studies need to be conducted to identify and quantify different goals of farmers and incorporate these in farm planning. Also possibilities of irrigation to minimize the vagaries of weather could be explored. Further research should also aim at establishing a data bank related to input use and individual crop yields in a mixture over a number of years.

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Appendix 1: T-MOTAD Matrix (Small Farm)

			M	Y	Ca	C	S	Me	M/S	M/S/Ca	M/Me	M/Ca	LABOUR HIRING UNIT J/F/M	A/M/J	J/A/S	O/N/D	CASH BORROWING	83	84	85	86	87	88	89	B/C
			114.2	809.02	1675.17	104.3	146.07	39.34	979.01	2474.29	1019.3	1201.63	-12.5	-12.5	-12.5	-12.5	-0.1								
Land (Ha)	(R01)	B/C	1	1	1	1	1	1	1	1	1	1													1.24
Family Labour Mandays JAN/FEB/MAR	(R02)	≤	31	54	40	0	0	20	31	41	43	45	-1												228
APR/MAY/JUNE	(R03)		39	86	25	15	27	39	38	34	36	36		-1											228
JULY/AUG/SEPT	(R04)		29	38	20	45	38	0	53	35	17	38			-1										228
OCT/NOV/DEC	(R05)		41	22	18	0	0	0	0	35	0	24				-1									228
Hired Labour Mandays JAN/FEB/MAR	(R06)	≤											1												210
APR/MAY/JUNE	(R07)													1											210
JULY/AUG/SEPT	(R08)														1										210
OCT/NOV/DEC	(R09)															1									210
Family Cash (₦)	(R10)		110	350	220	68	87	41	138	320	133	240	12.5	12.5	12.5	12.5	-1								1000
Cash Borrowing (₦)	(R11)																1								1000
Risk Constraints																									
Year 1 (83)	(R12)	≥	+436.7	+372.6	+258.9	-57.5	-19.7	-289.2	-163.2	-1477.7	-222.0	-871.6						+1							+2500
Year 2 (84)	(R13)		+936.9	+492.1	+398.3	-48.0	-64.4	-260.1	-580.6	-2466.4	-721.3	-1367.8							+1						+2500
Year 3 (85)	(R14)		+980.8	+613.1	+427.0	-65.1	-141.1	-178.6	-846.2	-2778.0	-815.2	[illegible]								+1					+2500
Year 4 (86)	(R15)		+1244.0	+517.1	+460.4	-72.1	-137.3	-191.3	-975.5	-3145.6	-1032.1	-1659.9									+1				+2500
Year 5 (87)	(R16)		+861.7	+746.4	+605.3	-88.6	-105.3	-51.4	-669.5	-3631.5	-2501.5	-1952.3										+1			+2500
Year 6 (88)	(R17)		+2770.9	+1353.2	+1169.4	-206.1	-303.1	-136.0	-2344.5	-3405.6	-2571.7	-554.6											+1		+2500
Year 7 (89)	(R18)		+1120.6	+1397.9	+1386.9	+403.6	-251.7	-201.9	-1273.7	-1325.4	-1022.3	-546.7												+1	+2500
Minimum Food Constraint																									
Min. Maize (Tonnes)	(-R19)	≥	1.8						1.6	1.4	1.7	1.9													0.94
Min. Cassava "	(-R20)				12.0					9.9		10.3													2.77
Min. Sorghum "	(-R21)						1.1		0.93	0.8															0.64
Min. Yam "	(-R22)			14.3																					3.91
Min. Melon "	(-R23)							0.4			0.15														
Min. Cowpea "	(-R24)					0.45																			0.04
Sum of Total Absolute Deviation Constraint	(R25)	=																0.142	0.142	0.142	0.142	0.142	0.142	0.142	λ

APPENDICES

APPENDIX 3: DEFINITION OF TERMS USED IN THE STUDY

TERM	DEFINITION
MAD	Mean Absolute Deviation of Returns
TAD	Total Absolute Deviation of Returns
MOTAD	Minimization of Total Absolute Deviation of Returns
T-MOTAD	Target Minimization of Total Absolute Deviation of Returns
SD	Standard Deviation
C.V.	Coefficient of Variation
TVC	Total Variable Cost
GVP	Gross Value of Output
G.ME.	Gross Margin of Enterprises

CROP	
MZE	Maize
YAM	Yam
CSV	Cassava
SGM	Sorghum
MZE/CSV	Maize/Cassava
MZE/SGM	Maize/Sorghum
MZE/MEL	Maize/Melon
MZE/SGM/CSV	Maize/Sorghum/Cassava
LCP	Local Cowpea

APPENDIX 4: GROSS MARGIN OF ENTERPRISES 1989/90

Crop/Crop Mixture	Yield T/Ha	Price N/T	GVP N/T	TVC N/Ha	GME N/Ha
MZE	1.14	1062	1187.8	129.97	457.83
YAM	8.52	720	61.34.4	4736.46	1397.94
CSV	11.2	220	2464.0	1077.07	1386.93
MEL	0.4	4730	1892	1690.12	201.88
SGM	0.84	1121	941.64	689.91	251.73
LCP	0.36	5620	2023.2	1619.6	403.6
MAZ/SGM	1.01/ 0.93	1042/ 1121	2094.95	821.29	1273.66
MAZ/MEL	1.1/ 0.15	1042/ 5730	2005.7	983.44	1022.26
MAZ/CSV	1.0/ 9.98	1042/ 220	3237.6	2690.9	546.7
MAZ/SGM/CSV	1.0/ 0.8/ 9.94	1042/ 1121/ 220	4125.6	2800.2	1325.4

Source: Field Survey 1989/90

APPENDIX 5: ESTIMATED YIELD CONVERSION FACTORS FOR MIXED CROP

CROP MIXTURE	YIELD CONVERSION FACTOR		
MAZ/SGM	MZE	x	0.8859
	SGM	x	1.1071
MAZ/SGM/CSU	MAZ	x	0.8859
	SGM	x	0.9523
	CSV	x	0.8875
MAZ/MEL	MAZ	x	0.9649
	MEL	x	0.3750
MAZ/CSV	MAZ	x	0.87719
	CSV	x	0.89107

Source: **Computed from Appendix 4**

APPENDIX 6: HISTORICAL GROSS MARGIN ANALYSIS OF CROPS/CROP MIXTURE (1983-1985)

	1983					1984					1985				
CROP/CROP MIXTURE	YIELD T/HA	PRICE N/T	TVC N	GVP N	GME N	YIELD T/HA	PRICE N/T	TVC N	GVP N	GME N	YIELD T/HA	PRICE N/T	TVC N	GVP N	GME N
MZE	0.89	542.69	297.17	482.99	185.82	0.88	720.37	283.50	633.92	450.42	1.20	710.10	338.72	852.12	513.48
YAM	8.10	130.57	826.74	1057.62	230.88	10.4	107.12	877.48	1114.05	236.56	10.4	110.45	827.71	3849.6	320.97
CSV	8.00	94.15	643.05	753.2	110.15	9.0	94.17	656.04	847.53	191.49	9.0	102.38	697.89	921.42	223.53
MEL	0.18	1871.88	459.98	336.93	-123.05	0.3	1871.26	436.36	561.38	125.02	0.2	2023.14	311.11	404.63	93.52
SGM	1.0	402.22	393.85	402.22	8.37	1.1	402.22	411.5	442.44	130.94	1.0	523.68	449.79	523.68	73.89
LCP	0.31	1687.6	498.7	523.16	24.46	0.41	1687.13	668.67	691.72	23.05	0.4	1614.1	611.54	645.64	34.1
MAZ/SGM	0.76/ 0.84	-	680.88	750.31	69.43	0.76/ 0.93	-	642.43	921.54	279.11	0.92/ 0.84	-	482.87	925.88	443.01
MZE/MEL	0.74/ .068	-	1480.01	1674.47	194.46	0.74/ 0.11	-	392.12	738.91	346.79	0.93/ 0.08	-	226.34	653.12	426.78
MZE/CSV	0.77/ 6.84	-	690.95	1061.86	370.91	0.77/ 7.7	-	622.18	1279.79	657.61	0.90/ 7.7	-	500.1	1263 75	763 65
MZE/SGM/CSV	0.72/ 0.68/ 6.63	-	659.67	1288.46	628.79	0.72/ 0.83/ 7.45	-	1185.03	2410.99	1185.76	0.89/ 0.75/ 7.45	-	1171.24	2625.63	1454.39

Source: Computed from Oyo North ADP Records

APPENDIX 7: HISTORICAL GROSS MARGIN ANALYSIS OF CROPS/CROP MIXTURE (1986-1988)

	1986					1987					1988				
CROP/CROP MIXTURE	YIELD T/HA	PRICE N/T	TVC N	GVP N	GME N	YIELD T/HA	PRICE N/T	TVC N	GVP N	GME N	YIELD T/HA	PRICE N/T	TVC N	GVP N	GME N
MZE	1.33	845.0	321.28	1123.88	802.59	1.32	850	403.95	1122.0	718.05	1.35	1054.75	602.69	1423.91	821.22
YAM	11.82	110.5	991.96	1306.11	334.15	11.80	110.55	882.5	1304.5	621.99	13.2	220.0	1550.85	2904.0	1353.15
CSV	12.4	72.76	592.26	902.22	309.96	12.7	80.28	515.14	1019.56	504.42	11.5	144.69	494.56	1663.94	1169.38
MEL	0.20	2173.49	311.28	434.69	123.41	0.3	1915.39	531.82	574.62	42.8	^3	2539.89	625.99	761.97	135.98
SGM	1.2	433.16	428.25	519.79	88.54	1.1	443.54	400.11	487.89	87.78	1.1	653.3	415.55	718.63	303 08
LCP	0.4	1613.5	598.89	645.4	46.51	0.4	1672.83	595.28	669.13	73.85	0.4	1966.45	580.5	786.58	206.08
MAZ/SGM	0.92/ 1.01	-	585.53	1214.89	629.36	1.0/ 0.93	-	704.59	1262.49	557.9	0.89/ 0.93	-	720.23	2064.74	1344.51
MAZ/MEL	1.0/ 0.076	-	344.29	1010.18	665.89	1.1/ 0.11	-	520.24	1145.69	625.45	0.92/ 0.114	-	688.20	1259.92	571.72
MAZ/CSV	0.99/ 11.46	-	600.05	1670.38	1070.32	1.0/ 11.71	-	1163.14	2790.07	1626.93	0.89/ 9.83	-	806.48	1361.03	554 55
MAZ/SGM/CSV	0.89/ 0.91/ 11.09	-	629.87	2659.28	2029.41	1.12/ 0.83/ 11.35	-	1211.21	2237.45	1026.23	0.9/ 0.83/ 9.53	-	1324.6	2827.2	1495.6

Source: Computed from Oyo North SDP Records

APPENDIX 8: HISTORICAL GROSS MARGIN FOR CROP/CROP MIXTURE (1983 - 1989)

CROP/CROP MIXTURE	G. M. 1983	G. M. 1984	G. M. 1985	G. M. 1986	G. M. 1987	G. M. 1988	G. M. 1989
MZE	185.82	450.42	513.48	802.59	718.05	821.22	1007.43
YAM	230.88	236.56	320.97	334.15	621.99	1353.15	1256.74
CSV	110.15	191.49	223.53	309.96	504.42	1169.38	1246.85
MEL	-123.05	125.02	93.52	123.41	42.8	135.98	181.49
SGM	8.37	30.94	73.89	88.54	87.78	303.08	226.30
LCP	24.46	23.05	34.1	46.51	73.85	206.08	119.24
MZE/SGM	69.43	279.11	443.01	629.36	557.90	2344.51	1145.02
MZE/MEL	94.46	346.79	426.78	665.89	625.45	2571.72	919.01
MZE/CSV	370.91	657.61	763.65	1070.32	1626.93	554.55	491.48
MZE/SGM/CSV	628.79	1186.76	1454.39	2029.41	2026.23	2495.6	1191.53

Source: Computed from ADP Annual Agronomic Survey Data and Staff Appraisal Records (1984 - 1990)

APPENDIX 9: GDP DEFLATORS (1983 - 1989)

YEARS	GDP DEFLATOR
1983	235.00
1984	208.00
1985	191.00
1986	155.00
1987	120.00
1988	100.00
1989	89.90

Source: Federal Ministry of Budget and Planning
Economic and Statistical Review 1991

APPENDIX 10: HISTORICAL GROSS MARGIN FOR CROP/CROP MIXTURE (1983 - 1989)

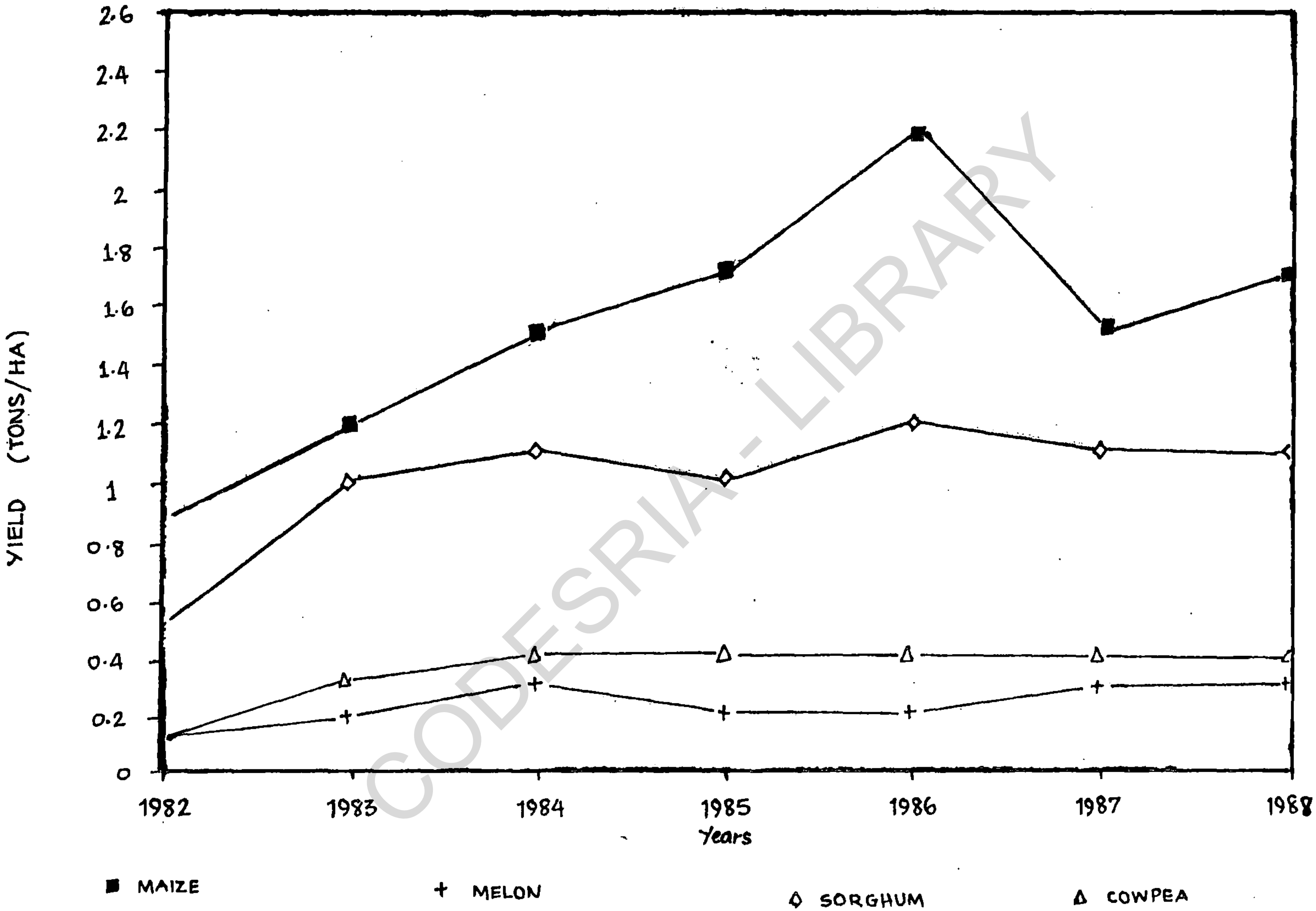
(GDP DEFLATED)

CROP/CROP MIXTURE	G.M. 1983	G.M. 1984	G.M. 1985	G.M. 1986	G.M. 1987	G.M. 1988	G.M. 1989	AVERAGE G.M. 1983-1989
MZE	436.69	936.88	980.76	1244.02	861.66	1342.4	457.83	894.32
YAM	542.58	492.05	613.06	517.94	746.39	1353.15	1397.94	809.02
CSV	258.86	398.30	426.95	480.44	605.31	1169.38	1386.93	675.17
MEL	-289.16	-260.05	178.64	-191.29	-51.37	135.98	201.88	-39.34
SGM	19.67	64.36	141.13	137.25	105.34	303.08	251.73	146.07
LCP	-57.49	-47.96	65.14	72.10	88.63	206.08	132.64	104.3
MZE/SGM	163.18	580.56	846.15	975.52	669.49	2344.51	1273.66	979.01
MZE/MEL	221.99	721.33	815.15	1032.14	750.54	2571.72	1022.26	1019.30
MZE/CSV	871.64	1367.84	1458.58	1659.83	1952.32	554.55	546.7	1201.63
MZE/SGM/CSV	1477.67	2466.4	2777.9	3145.60	3631.48	2495.6	1325.4	2474.29

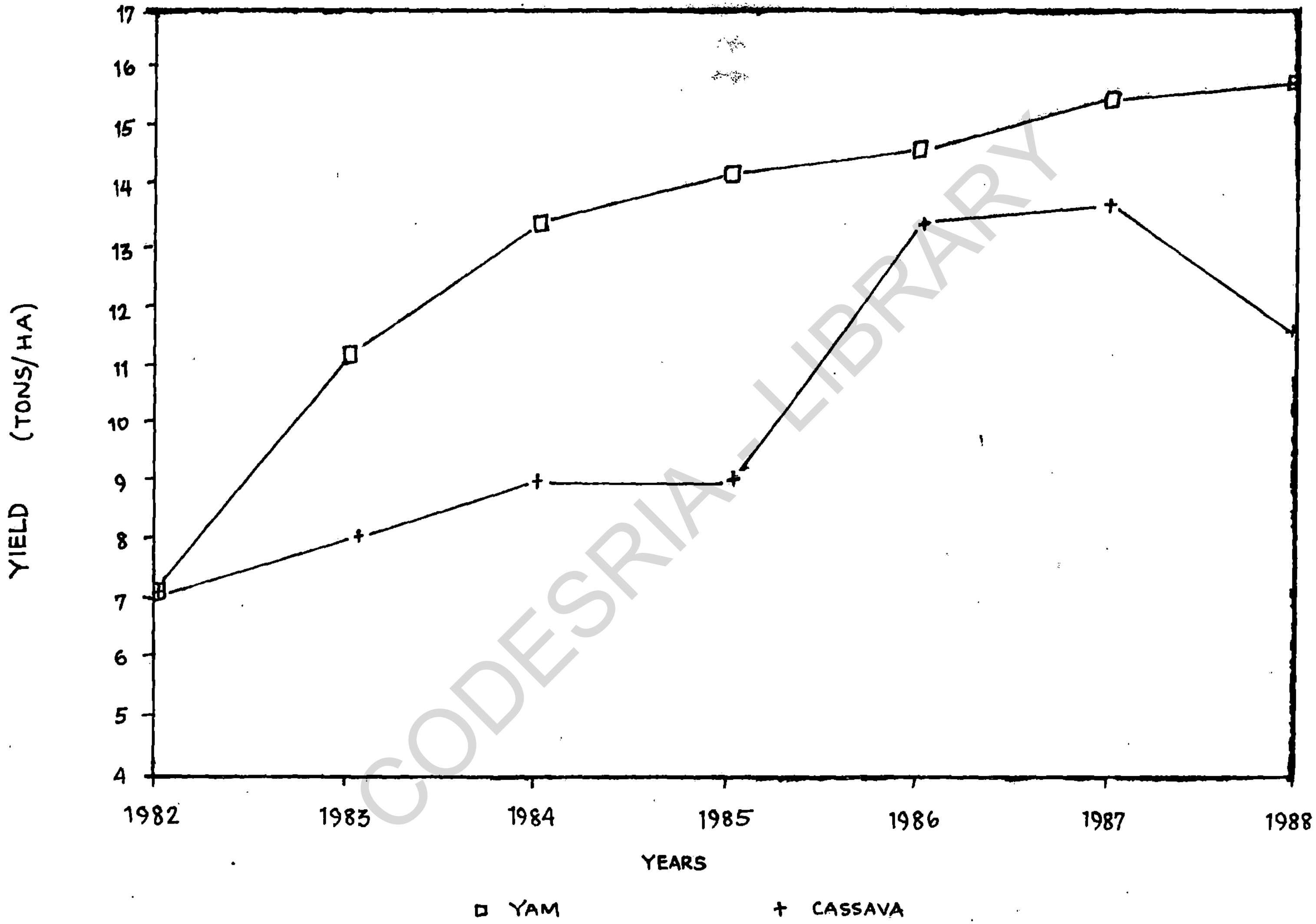
Source: Computed from ADP Annual Agronomic Survey Data and Staff Appraisal Records (1984 - 1989) Appendices 8 & 9.

HISTORICAL YIELD OF SOLE CROPS

Maize (M) ; Sorghurm (S) ; Cowpea (CP) ; Melon (ME)

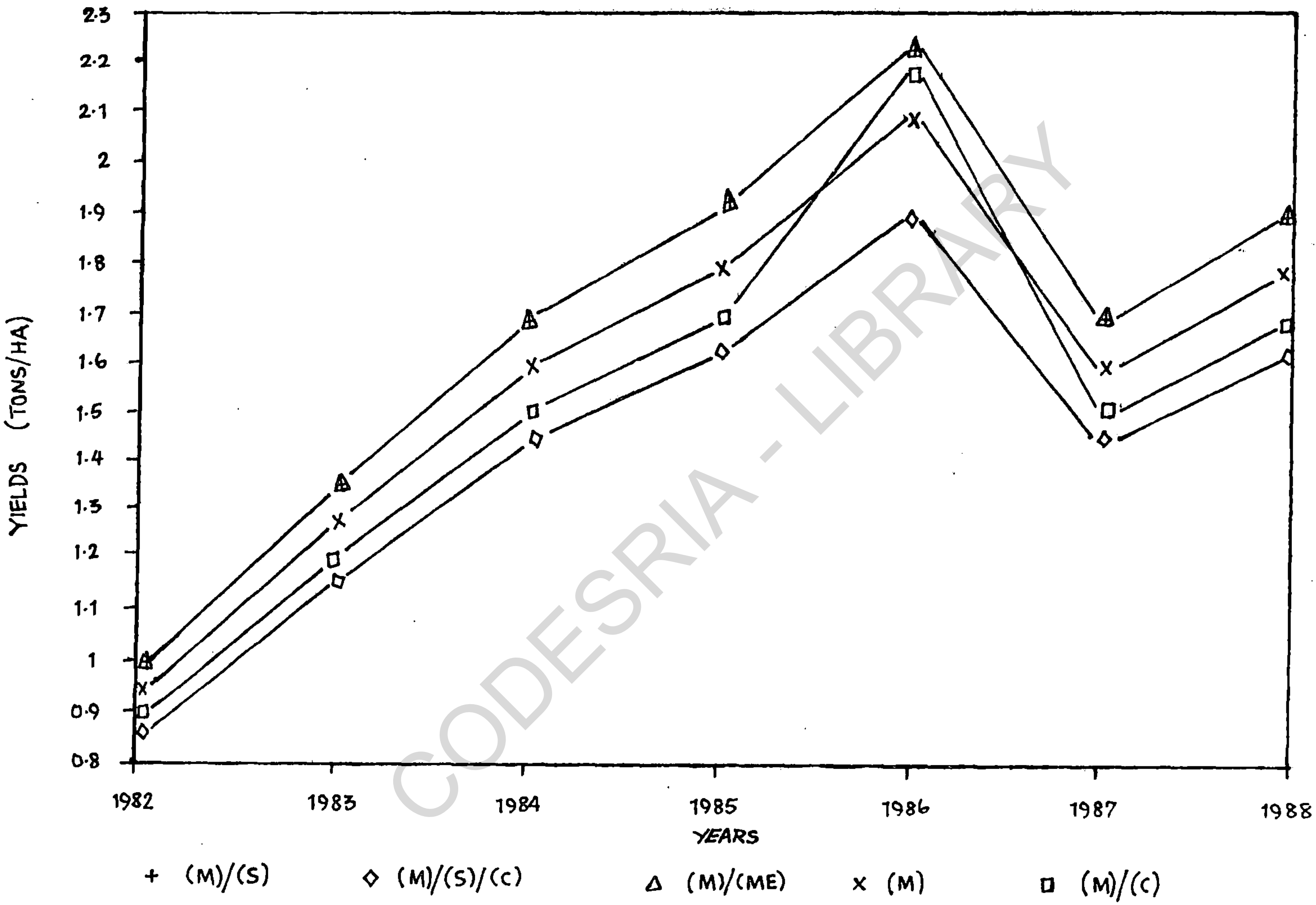


HISTORICAL YIELD OF SOLE CROPS
Yam (Y) ; Cassava (C)



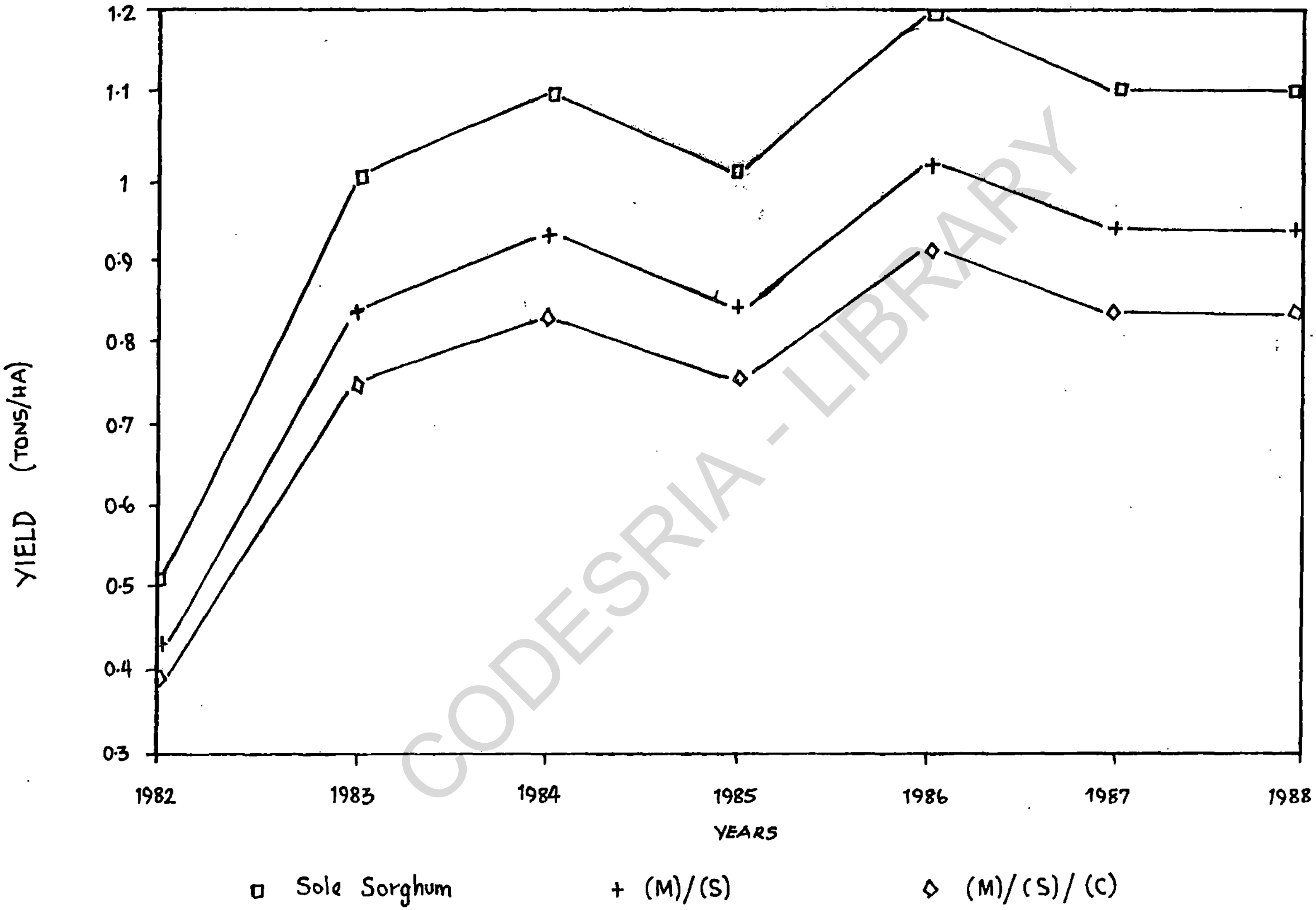
HISTORICAL YIELD OF MAIZE UNDER SOLE AND MIXED CROPPING

Maize (M); Sorghum (S); Cassava (C); Melon (ME)

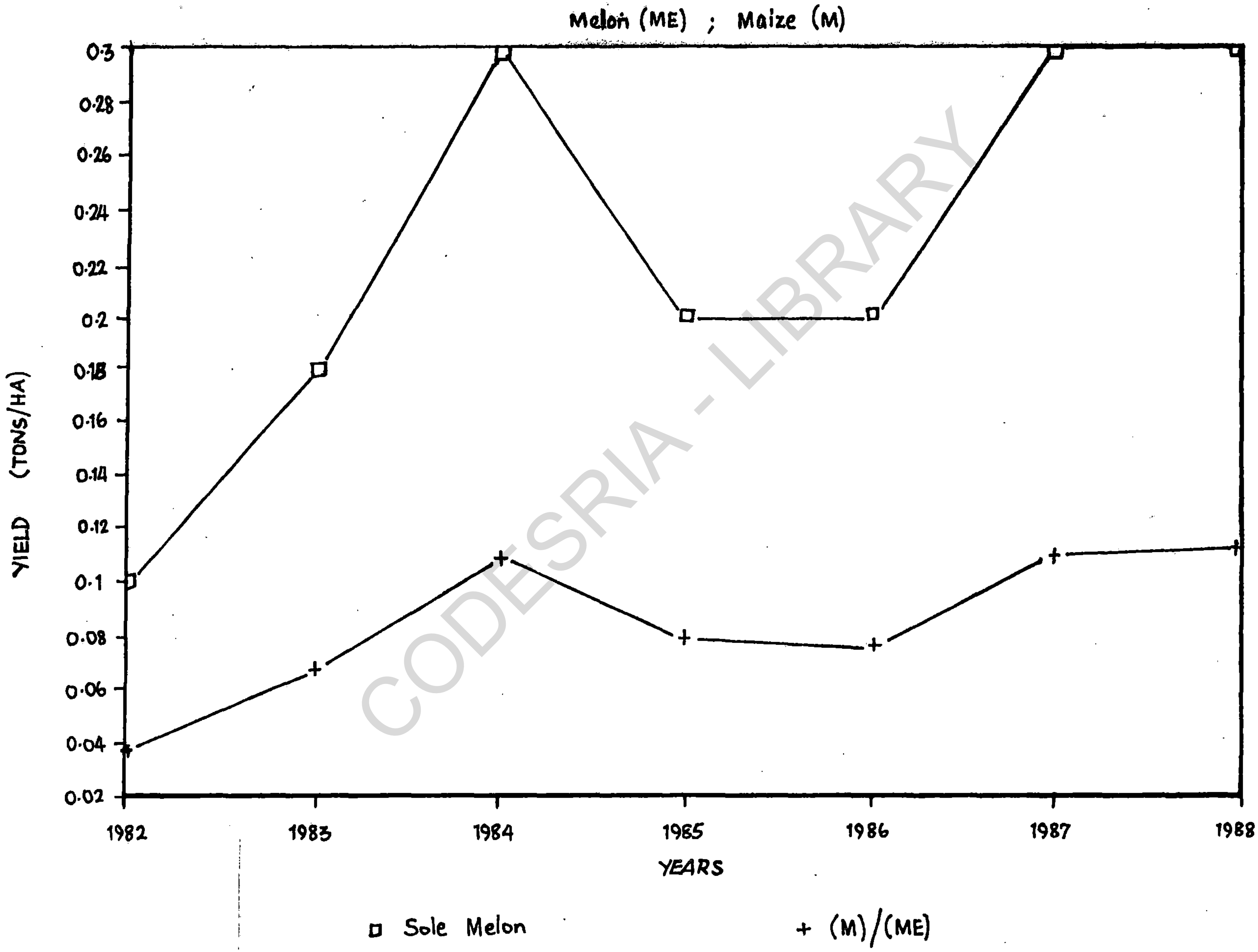


HISTORICAL YIELD OF SORGHUM UNDER SOLE AND MIXED CROPPING

Maize (M) ; Sorghum (S) ; Cassava (C) ; Melon (ME)



HISTORICAL YIELD OF MELON UNDER SOLE AND MIXED CROPPING

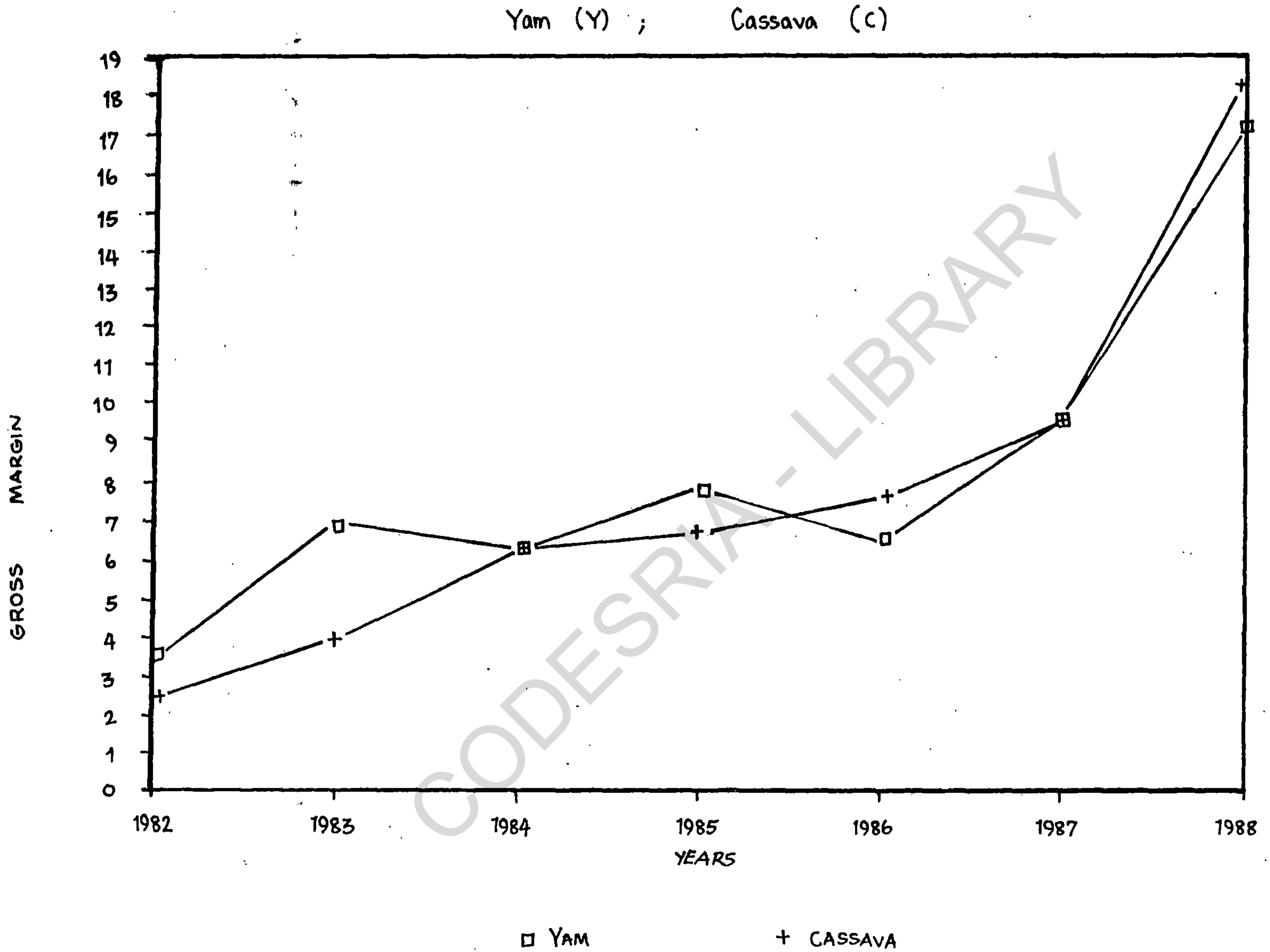


HISTORICAL YIELD OF CASSAVA UNDER SOLE AND MIXED CROPPING

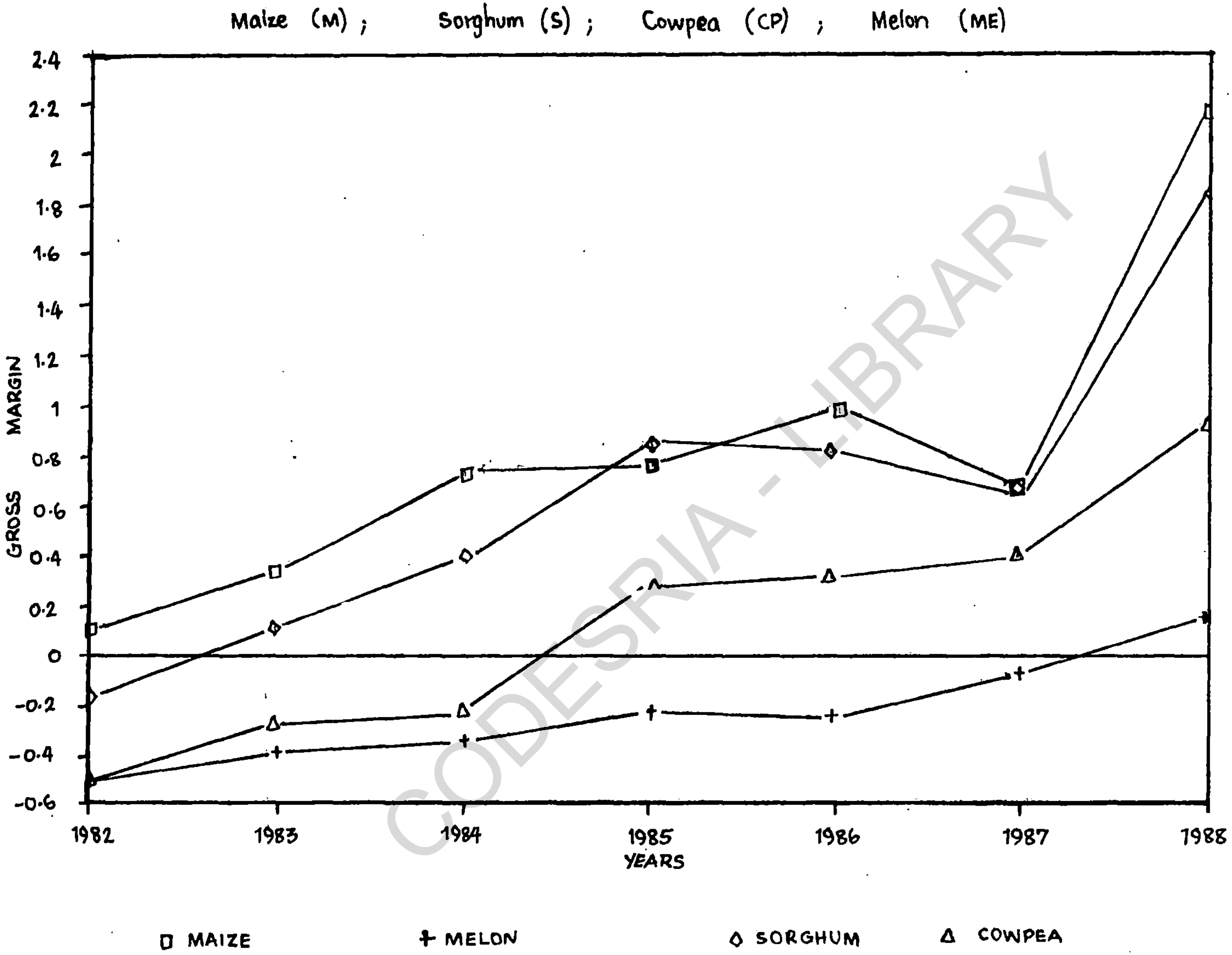
Maize (M) ; Sorghum (S) ; Cassava (C) ; Melon (ME)

Appendix 17

HISTORICAL GROSS MARGIN OF SOLE CROPS



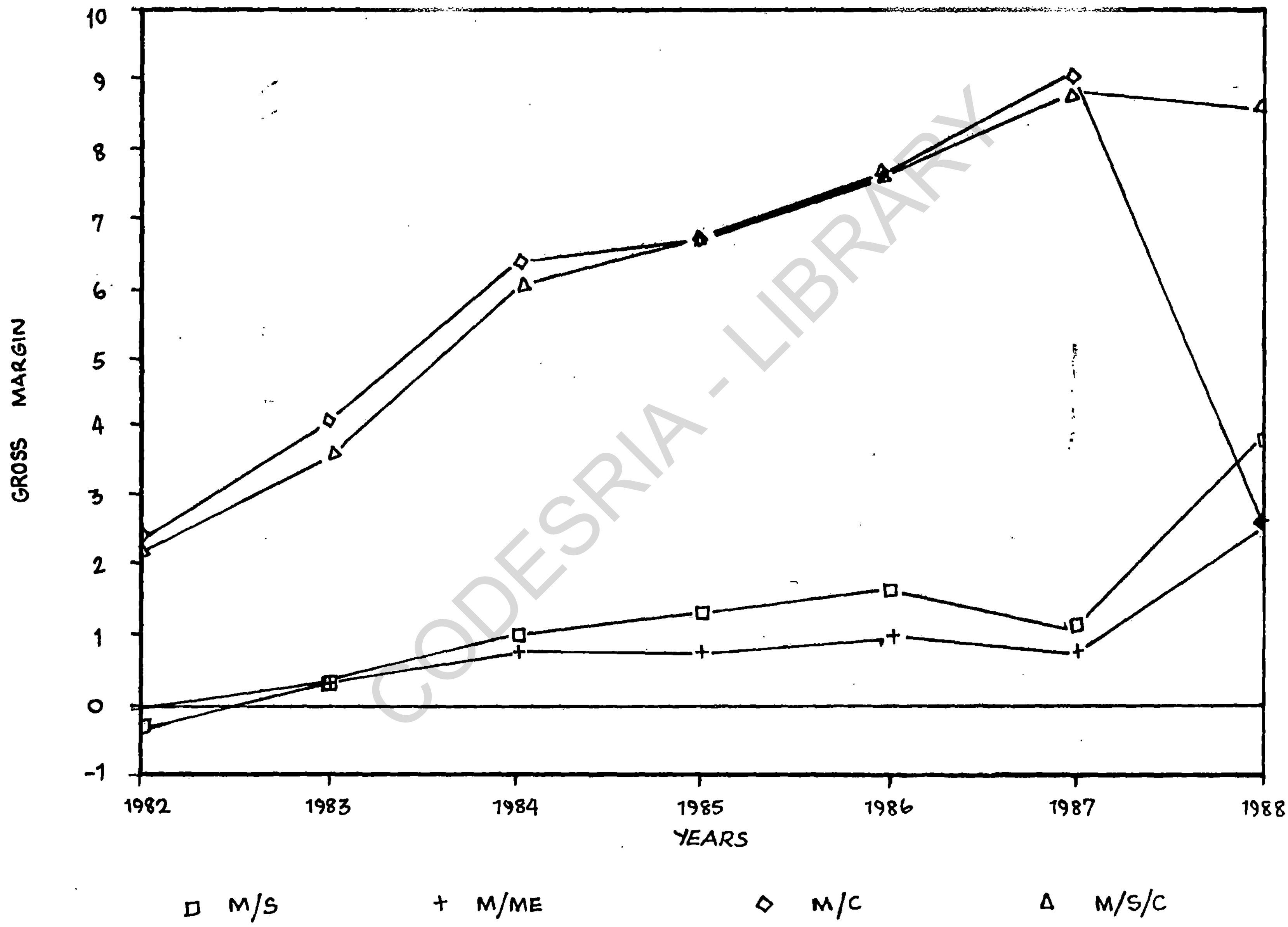
HISTORICAL GROSS MARGIN OF SOLE CROPS



Appendix 19

HI... ?ICAL ... ...GIN OF MIXED CROP...

Maiz... Sorghurm (S) ; Cassava (... ...ME)



APPENDIX 20 REGRESSION RESULTS: VARIABLES REPRESENTING NATURE OF FARMERS HOUSEHOLD (LINEAR FUNCTIONAL FORM)

Variables Steps	Age	Family Size	Farming Years	Education	R^2	$\bar{R}^2$	F	Intercept	Std Error of Estimate
1	-.0046 (-5.01)				.66	.62	25.16	.53	0.49
2.	-.0041 (-3.93)	-.003 (-1.03)			.67	.65	13.14	.53	.049
3.	-.003 (-1.44)	-.004 (-1.17)	-.002 (-1.08)		0.69	.67	9.20	.50	.05
4.	-.002 (-.96)	-.005 (-1.38)	-.003 (-1.49)	-.002 (-1.21)	.71	.70	7.37	.50	.048

*(t - ratio are in parentheis)

APPENDIX 21 REGRESSION RESULTS: VARIABLES REPRESENTING NATURE OF FARMERS HOUSEHOLD (LOGARITHM FUNCTIONAL FORM)

Variables Steps	Age	Family Size	Farming Years	Education	R^2	$\bar{R}^2$	F	Intercept	Std Error of Estimate
1	-.59 (-4.98)				.66	.64	20.82	.48	.065
2.	-.40 (-1.49)	-.08 (-.78)			.67	.64	12.56	.26	.066
3.	-.36 (-1.75)	-.08 (-.81)	-.03 (-.60)		.67	.65	8.32	.21	.066
4.	-.35 (-1.18)	-.08 (-1.78)	-.03 (-1.59)	-.24E-7 (-1.03)	.67	.66	6.03	.21	.07

* (t ratio are in parenthesis)

APPENDIX 22 REGRESSION RESULTS: VARIABLES REPRESENTING NATURE OF FARMERS HOUSEHOLD (SEMI-LOG FUNCTIONAL FORM)

Variables Steps	Age	Family Size	Farming Years	Education	R^2	$\bar{R}^2$	F	Intercept	Std Error of Estimate
1.	-.46 (-5.15)				.67	.62	26.48	1.08	.48
2.	-.43 (-4.29)	-.02 (-.52)			.68	.65	13.07	1.05	.05
3.	-.35 (-1.63)	-.02 (-.54)	-.03 (-.44)		.68	.67	8.55	.96	.05
4.	-.35 (-1.58)	-.02 (-.53)	-.04 (-.43)	-.28 (-.04)	.68	.67	6.20	.95	.05

*(t - ratio are in parenthesis)

APPENDIX 23 REGRESSION RESULTS: VARIABLES REPRESENTING NATURE OF FARMERS HOUSEHOLD (EXPONENTIAL FUNCTIONAL FORM)

Variables Steps	Age	Family Size	Farming Years	Education	R^2	$\bar{R}^2$	F	Intercept	Std Error of Estimate
1.	-.006 (-4.87)				.68	.65	23.70	-.22	0.07
2.	-.004 (-2.64)	-.004 (-1.35)			.68	.67	13.06	-.28	.07
3.	-.002 (-1.83)	-.004 (-1.53)	-.006 (-1.31)		.70	.69	9.48	-.29	.06
4.	-.001 (-1.73)	-.005 (-1.92)	-.007 (-1.53)	-.003 (-1.27)	.72	.70	7.65	-.28	.06

*(t ratio are in parenthesis)

APPENDIX 24 REGRESSION RESULTS: VARIABLES REPRESENTING INCOME GENERATING POTENTIAL OF FARMERS (LINEAR FUNCTIONAL FORM)

Variables Steps	workers	Cropped Area	Off-farm Income	Farm Income	Square of cropped area	R^2	$\bar{R}^2$	F	Intercept	Std. Error of Estimate
1.	-.02 (-2.57)					.44	.041	6.62	.38	.06
2.	-.02 (-2.16)	.008 (1.33)				.47	0.46	4.27	.35	.06
3.	-.02 (-2.31)	.01 (2.12)	.15 (2.00)			.58	0.56	4.46	.29	.06
4.	-.02 (-2.33)	.012 (1.82)	.157 (2.02)	.55 (.63)		.58	0.56	3.37	.29	.06
5.	-.02 (-2.29)	.013 (1.94)	.15 (1.83)	.573 .63	-.20 (-.11)	.58	0.56	2.61	.29	.06

*(t - ratio are in parenthesis)

APPENDIX 28 REGRESSION RESULTS: VARIABLES REPRESENTING INCOME GENERATING POTENTIAL OF FARMERS

(LOGARITHM FUNCTIONAL FARM)

Variables Steps	workers	Cropped Area	Off-farm Income	Farm Income	Square of cropped area	R^2	$\bar{R}^2$	F	Intercept	Std. Error of Estimate
1	-.14 (-2.36)					.38	.36	5.56	-.44	.08
2	-.16 (-2.60)	.04 (1.16)				.43	.40	3.49	-.55	.08
3	-.15 (-2.58)	.05 (1.67)	.09 (1.50)			.49	.45	3.17	-.65	.08
4	-.16 (-2.72)	.07 (1.90)	.08 (1.37)	.06 (.96)		.51	.50	2.60	-.89	.08
5.	-.16 (-2.43	.06 (1.60)	.17 (.63)	.06 (.82)	-.05 (-.33)	.51	.50	2.04	-.56	.08

*(t - ratio are in parenthesis)

APPENDIX 26 REGRESSION RESULTS: VARIABLES REPRESENTING INCOME GENERATING POTENTIAL OF FARMERS

(SEMI-LOG FUNCTIONAL FORM)

Variables Steps	workers	Cropped Area	Off-farm Income	Farm Income	Square of cropped area	R^2	$\bar{R}^2$	F	Intercept	Std. Error of Estimate
1	-.11 (-2.43)					.40	.38	5.91	.37	.06
2	-.10 (-2.25)	.05 (1.09)				.43	.40	3.56	.34	.06
3	-.11 (-2.61)	.07 (1.63)	.04 (1.57)			.45	.43	3.30	.21	.06
4	-12 (-2.76)	.07 (1.49)	.05 (1.83)	.05 (1.03)						
5	-.12 (-2.47)	.13 (.65)	.04 (1.54)	.05 (.89)	-.03 (-.32)	.53	.51	2.15	.05	.06

*(t - ratio are in parenthesis)

APPENDIX 27 REGRESSION RESULTS: VARIABLES REPRESENTING INCOME GENERATING POTENTIAL OF FARMERS

(EXPONENTIAL FUNCTIONAL FORM)

Variables Steps	workers	Cropped Area	Off-farm Income	Farm Income	Square of cropped area	R^2	$\bar{R}^2$	F	Intercept	Std. Error of Estimate
1	-.03 (-2.57)					.41	.40	6.60	-.42	.08
2.	-.03 (-2.76)	.13 (1.33)				.46	.43	4.26	-.44	.08
3.	-.02 (-2.36)	.21 (2.08)	.02 (1.93)			.55	.52	4.38	-.53	.07
4.	-.02 (-2.37)	.22 (2.09)	.02 (1.66)	.64 (.55)		.56	.54	3.24	-.54	.08
5	-.02 (-2.34)	.21 (1.87)	.02 (1.11)	.69 (.57)	-.46 (-.18)	.56	.54	2.51	-.54	.08

*(t - ratio are in parenthesis)

APPENDIX 28 REGRESSION RESULTS: VARIABLES REPRESENTING FARMERS ACCESS TO INSTITUTIONS

(LINEAR FUNCTIONAL FORM)

Variables Steps	Years as ADP Content Farmer	Loan Procurement	Membership of Community Association	R^2	$\bar{R}^2$	F	Intercept	Std. Error of Estimate
1	-.015 (-3.26)			.50	.49	10.60	.36	.06
2	-.02 (-2.65)	.032 (.89)		.53	.52	5.66	.36	.06
3	-.02 (-2.59)	.03 (.71)	.002 (.06)	.54	.52	3.65	.36	.06

*(t- ratio are in parenthesis)

APPENDIX 29. REGRESSION RESULTS: VARIABLES REPRESENTING FARMERS ACCESS TO INSTITUTIONS

(LOGARITHM FUNCTIONAL FORM)

Variables Steps	Years as ADP Content Farmer	Loan Procurement	Membership of Community Association	R^2	$\bar{R}^2$	F	Intercept	Std. Error of Estimate
1	-.26 (-2.89)			.46	.43	8.38	-.52	.08
2	-.30 (-2.05)	.02 (.40)		.46	.43	4.61	-.54	.08
3	-.31 (-2.07)	.04 (.61)	-.02 (-.47)	.47	.43	2.77	-.54	.08

*(t - ratios are in parenthesis)

APPENDIX 30: REGRESSION RESULTS: VARIABLES REPRESENTING FARMERS ACCESS TO INSTITUTIONS

(SEMI-LOG FUNCTIONAL FORM)

Variables SSteps	Years as ADP Contact Farmer	Loan Procurement	Membership of a Comm. Association	R^2	$\bar{R}^2$	F	Intercept	Std. Error of Estimate
1.	-.20 (-3.06)			.47	.40	9.35	.30	.06
2	-.26E-5 (-2.33)	.02 (.62)		.49	.45	4.77	.28	.06
3	-.26E-5 (-2.35)	.04 (.83)	-.02 (-.56)	.49	.45	3.22	.28	.06

*(t - ratio are in parenthesis)

APPENDIX 31: REGRESSION RESULTS: VARIABLES REPRESENTING FARMERS ACCESS TO INSTITUTIONS

(EXPONENTIAL FUNCTIONAL FORM)

Variables Steps	Years as ADP Contact Farmer	Loan Procurement	Membership of a Comm. Association	R^2	$\bar{R}^2$	F	Intercept	Std. Error of Estimate
1	-.02 (-3.15)			.49	.47	9.93	-.45	.08
2	-.02 (-2.45)	.04 (.73)		.53	.50	5.16	-.45	.08
3	-.02 (-2.40)	.03 (.56)	.005 (.09)	.53	.50	3.32	-.45	.08

*(t - ratios are in parenthesis)

APPENDIX 32: REGRESSION RESULTS: RISK COEFFICIENTS VERSUS FARMERS SOCIO-ECONOMIC VARIABLES

(LINEAR FUNCTIONAL FARM)

Age	Farm Income	Family Size	Off-farm Income	Farming years	Loan (N)	Cropped area	Loan pro-ment	Member-ship of Comm. Assoctn	Years of ADP Contract farmer	Cropping intensity	No. of Workers in	Edu-cation	R^2	R^2	F	Inter-cept	Std. Error of Estimate
-.005													.68	.66	25.16	.53	.05
(-5.02)																	
-.005	.14E-4												.73	.71	16.25	.52	.05
(-5.57	(2.13)																
-.004	.15E-4	-.004											.75	.73	11.47	.52	.05
(4.42)	(2.21)	(-1.21)															
-.004	.16E-4	-.004	.65										.76	.74	9.00	.50	.05
(-4.46)	(2.40)	(1.14)	(1.13)														
-.003	.16E-4	-.004	.65	-.002									.78	.76	7.51	.47	.05
(-1.73)	(2.39)	(-1.39)	(1.14)	(1.12)													
-.003	.16E-4	-.004	.48	-.002	-52								.78	.76	6.31	.47	.05
(-1.55)	(2.33)	(1.29)	(.79)	(-1.22)	(-.84)												
-.002	.13E-4	-.004	.74	-003	-.70	.006							.79	.78	5.60	.43	.05
(-1.22)	(1.74)	(1,74)	(1.13)	(-1.31)	(1.06)												
-.003	.16E-4	-.004	.92	-.002	-.99	.006	.02						.79	.78	4.98	.44	.05
(1.51)	(1.95)	(-1.10)	(1.34)	(-1.05)	(-1.40)	(.99)	(.93)										
-.003	.18E-4	-.005	.12	-.003	-.86	.005	.06	-.05					.82	.80	4.84	.43	.05
(-1.32)	(2.22)	(-1.31)	(1.74)	(-1.20)	(.87)	1.68	(-1.43)										
-.002	.15E-4	-.004	.11	-.003	-.76	.006	.07	-.04	-.007				.83	.81	4.47	.41	.05
(-1.10)	(1.90)	(-.10)	(1.61)	(-1.37)	(-1.06)	(1.03)	(1.93)	(-1.13)	(-1.03)								
.004	.15E-4	-.004	.11	-.003	-.83	.006	.08	-.04	-.006	-.02			.83	.81	3.91	.43	.05
(1.82)	(1.84)	(-.10)	(1.54)	-1.38	-1.08	(1.03)	(1.91)	(-1.13)	(-.87)	(-.31)							
-.002	.15E-4	-.003	.12	-.003	-.87	.006	.07	-.04	-.006	-.02	-.002		.83	.81	3.43	.43	.05
(-1.11)	(1.79)	(-.46)	(1.50)	(-1.27)	(-1.07)	(1.01)	(1.83)	(-.96)	(-.80)	(-.30)	(-.20)						
-.002	.15E-4	-.003	.12	-.003	-71	.006	.08	.04	-.006	-.02	-.002	-70					
(-1.07)	(1.69)	(-.47)	(1.48)	(-1.18)	(-.60)	(.89)	(1.77)	(-.95)	(-.79)	(-.34)	(-.21)	(-.19)					

APPENDIX 33: REGRESSION RESULTS: RISK COEFFICIENTS VERSUS FARMERS SOCIO ECONOMIC VARIABLES

(LOGARITHM FUNCTIONAL FORM)

Variable	Age	Farm Income	Off-farm Income	workers number	Farming Years	cropping intensity	Loan (₦)	Years as ADP contact farmer	Education	cropped area	Family Size	R^2	R^2	F	Intercept	Std. Error of Estimate
1	-.59 (-4.98)											.66	.64	24.82	.48	.07
2	-.63 (-5.31)	.08 (1.57)	[illegible] [illegible]									.69	.67	14.21	.29	.06
3	-.65 (-5.46)	.11 (1.96)	.03 (1.29)									.71	.69	10.24	.12	.06
4	-.57 (-4.45)	.12 (2.12)	.04 (1.67)	-.07 (-1.34)								.73	.70	8.32	-.03	.06
5	-.27 (-.99)	.12 (2.27)	.05 (1.85)	-.08 (-1.53)	-.13 (-1.28)							.75	.74	7.14	-.43	.06
6	-.24 (-.87)	.13 (2.43)	.06 (2.10)	-.09 (-1.65)	-.11 (-1.15)	.04 (1.07)						.76	.75	6.17	-.53	.06
7	-.32 (-1.12)	.15 (2.62)	.07 (2.32)	-.10 (-1.86)	-.10 (-1.03)	.04 (1.11)	.93 (.99)					.77	.76	5.43	-.51	.06
8	-.28 (-1.00)	.13 (2.28)	.07 (2.38)	-.09 (-1.62)	-.09 (-.97)	.06 (1.53)	.23 (1.88)	-.20 (-1.65)				.80	.78	5.40	-.52	.06
9	-.30 (-1.05)	.13 (2.29)	.06 (1.94)	-.08 (-1.44)	-.07 (-.72)	.07 (1.62)	.20 (1.43)	-.22 (-1.72)	.68 (.59)			.80	.78	4.71	-.49	.06
10	-.32 (-1.05)	.14 (2.19)	.06 (1.91)	-.08 (-1.43)	-.07 (-.69)	.07 (1.61)	.22 (1.23)	-.22 (-1.70)	.54 (.39)	-.02 (-.22)	[illegible] [illegible]	.80	.78	4.08	-.47	.06
11	-.31 (-1.02)	.14 (1.98)	.07 (1.62)	-.09 (-.88)	-.07 (-.67)	.07 (1.36)	.23 (1.17)	-.23 (-1.66)	.48 (.31)	-.01 (-.21)	.01 (.09)	.80	.78	3.55	-.47	.06

APPENDIX 34: REGRESSION RESULTS: RISK COEFFICIENT VERSUS FARMERS SOCIO-ECONOMIC VARIABLES

(SEMI-LOG FUNCTIONAL FORM)

Vari-able	Age	Farm Income	Off-farm income	workers number	Loan (N)	Years as ADP Contact Farmer	Cropping intensity	Education	family years	family size	cropped area	R^2	R^2	F	Intercept	Std. Er of Estim
1	-.46 (-5.15)											.67	.65	26.48	1.08	.05
2	-.49 (-5.59)	.07 (1.81)										.71	.67	15.81	.91	.05
3	-.50 (-5.69)	.08 (2.12)	.02 (1.15)									.73	.70	11.09	.72	.05
4	-.44 (4.66)	.09 (2.28)	.03 (1.54)	-.05 (-1.35)								.74	.73	9.00	.69	.05
5	-.49 (-4.76)	.11 (2.57)	.04 (1.90)	-.07 (-1.65)	.81 (1.17)							.76	.74	7.57	.69	.05
6	-.47 (-4.55)	.09 (2.14)	.04 (1.80)	-.05 (-1.36)	.18 (1.96)	-.14 (-1.60)						.78	.76	7.08	.70	.04
7	-.41 (-3.65)	.01 (2.30)	.05 (2.13)	-.06 (-1.49)	.20 (2.20)	-.17 (-1.90)	.04 (1.31)					.80	.78	6.47	.57	.04
8	-.38 (-3.28)	.10 (2.33)	.04 (1.73)	-.05 (-134)	.17 (1.67)	-.19 (-1.98)	.05 (1.45)	.54 (.67)				.80	.78	5.60	.55	.04
9	-.32 (-1.51)	.10 (2.30)	.04 (1.74)	-.06 (-1.36)	.17 (1.65)	-.18 (-1.88)	.04 (1.28)	.43 (.50)	-.03 (-.39)			.80	.78	4.82	.47	.05
10	-.32 (-1.47)	.10 (2.02)	.05 (1.58)	-.07 (-.98)	.19 (1.59)	-.19 (-1.86)	.04 (1.00)	.29 (.29)	-.36 (-.44)	.022 (.27)		.80	.78	4.18	.46	.05
11	-.32 (-1.41)	.10 (1.91)	.05 (1.58)	-.07 (-1.00)	.20 (1.33)	-.19 (-1.82)	.04 (.98)	.23 (.20)	-.04 (-.42)	.02 (.26)	-.006 (-.12)	.80	.78	3.64	.47	.05

APPENDIX 35: REGRESSION RESULTS: RISK COEFFICEINTS VERSUS FARMERS SOCIO-ECONOMIC VARIABLES

(EXPONENTIAL FUNCTIONAL FARM)

Variable Step	Age	Farm Income	Farming years	Family size	Off-farm income	loan (N)	cropped area	workers number	Years as ADP contact farmer	Cropping intensity	Education	Membership of Comm. Association	R^2	R^2	F	Intercept	Std Error of Estima
1	-.006 (-4.87)												.65	.64	23.70	-.22	.06
2	-.006 (-5.29)	.17 (1.86)											.70	.68	14.49	-.29	.06
3	-.004 (-1.90)	.17 (1.85)	-.003 (1.35)										.72	.70	10.53	-.30	.06
4	-.003 (-1.25)	.17 1.96	-.004 (-1.56)	-.007 (-1.46)									.74	.71	8.74	-.30	.06
5	-.003 (-1.27)	.20 (2.20)	-.004 (-1.59)	-.006 (-1.40)	.10 (1.32)								.76	.74	7.52	-.33	.06
6	-.002 (-1.09)	.20 (2.16)	-.004 (-1.69)	-.066 (-1.41)	.76 (.95)	-.72 (.88)							.77	.75	5.34	-.33	.06
7	-.002 (-.81)	.16 (1.62)	-.004 (-1.76)	-.006 (-1.25)	.11 (1.23)	-.93 (-1.10)	.008 (.94)						.77	.75	5.54	-.38	.06
8	-.002 (-.76)	.15 (1.50)	-.004 (-1.73)	-.003 (-.40)	.12 (1.34)	-.93 (1.09)	.008 (.95)	(-.65)					.78	.77	4.79	-.38	.06
9	-.001 (-.54)	.14 (1.29)	-.005 (-1.71)	-.003 (-.43)	.12 (1.17)	-.83 -.85	.008 (.96)	-.007 (-.48)	-.002 (-.25)				.78	.77	4.11	-.39	.06
10	-.001 (-.44)	.15 (1.29)	-.004 (-1.63)	-.003 (-1.50)	.12 (1.18)	-.72 (-.67	.008 (.90)	-.006 (-.42)	-.003 (-.29)	.02 (.26)			.78	.77	3.56	-.40	.06
11	-.001 (-.45)	.16 (1.29)	-.004 (-1.11)	-.003 (-.38)	.12 (1.15)	-.12 (-.73)	.009 (.95)	.006 (-.40)	.003 -.34	.03 (.38)	.002 (.37)		.78	.77	3.13	-.42	.06
12	-.001 (-.45)	.16 (1.29)	-.004 (-1.11)	-.003 (-.38)	.12 (1.12)	-.12 (-.70)	.009 (.93)	.006 (-.33)	.003 (-.23)	.02 (.33)	.002 (.38)	-.004 (-.09)	.78	.77	2.27	-.42	.06

Department of Agricultural Economics
University of Ibadan

PROJECT TITLE: An Empirical Analysis of Production Risk and Attitudes of Small Farmers in Oyo State, Nigeria

Individual Farmer Questionnaire

I. Socio-Economic Data

(1) (a) Name of Farmer (Optional)..................

(b) Village Name ....

(c) Ward .... Date of Interview................

(d) Local Government Area..........................

(2) (a) How old are you..................................

(b) How long have you been farming in this area

...... years

(c) Are you an ADP farmer ( ) yes ( ) No

(d) If yes, how long have you been an ADP farmer

...... years

(3) Years of formal Education .... years

(4) What is the total area of your farmland .... acres

(5) Which area out of this are cropped .... acres

(6) Land Ownership

(a) How did you obtain your land

( ) Inheritance ( ) Lease arrangement

( ) Gift ( ) family land

( ) Purchase ( ) Other (Specify)..

(b) If rented, how do you pay your rent

( ) In cash N .... ( ) In kind.....kg/crop

(c) Can you get extra land if you want to expand production ( ) yes ( ) No

(d) If yes, how will you get it

( ) family land ( ) purchase at N .... per acrea

( ) rent at N........ ( ) Gift ( ) Inheritance

(7) (a) Do you belong to any community association

( ) yes ( ) No

(b) If yes which one.......................................

(c) If no, why..

(8) (a) If you belong to an association, what are the advantages to members ....

....

(b) How much do you pay as membership fee N.......

marital status

(9) (a) ( ) married ( ) single ( ) Divorced

(b) If married, please fill the following table

Dependants	Number	Those living with you	Works (No)	Type of occupation
Wives				
Children (Male)				
Child. (Female)				
Relat. (Child.)				
Relat. (Adult)				

(10) What is your other occupation(s) apart from farming

....

(11) How much do you realize from this/these occupation/s

N .... year

(12) What proportion of your annual income comes from farming

....

II. Crop Data

(13) **(a) Cropping System**

What food crops do you grow ( ) maize ( ) Cassava

( ) Cowpea ( ) Sorghum ( ) Others (specify)

....

(14) How do you grow them

( ) Sole ( ) Mixed ( ) Sole and mixed

(15) Specify the mixed ones (a) ....

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

(e) ....

(b) Resources Used in Crop Production

(i) Capital Availability and Use

(16) (a) Did you apply for loan ( ) yes ( ) No

(b) If yes, from whom ....

(17) (a) How much did you apply for N ....

(b) How much did you get N ....

(c) What did you do with the loan ....

(d) What interest rate did you pay N ....

(18) How much did it cost you to clear and stump your land

N ....

(19) What method did you use in clearing, ploughing and ridging

( ) Using hand tool ( ) using animal drawn implements

( ) Use tractors ( ) other (specify) ....

(20) (a) If by tractor, how much did it cost you to hire

N ....

(b) How many hours/days did the tractor worked......days/hrs.

(c) On which farm did you use the tractor..............

(d) Who supplied the tractor ....

(e) What difficulties do you face in getting tractor services

(21) Please provide the following information

Items	Number	Unit cost (N)	Expected life Span
a. cutlass			
b. hoe			
c. shovels			
d. trowels			
e. file			
f. basket			
g. others			

(22) Did you apply fertilizer on your crops ( ) yes ( ) No

(23) (a) If No, why ....

(b) If yes, how did you apply fertilizer

( ) By broadcasting ( ) by banding or row application

( ) by ring application ( ) by others

(specify) ....

(c) Did you receive any assistance in doing this

( ) yes ( ) No

(d) If yes, from who ....

(24) How did you get the fertilizer ....

( ) purchased from market ( ) Gift ( ) supplied by ADP

( ) AISU ( ) Others (specify) ....

(25) (a) What is the recommendated level of fertilizer use by

ADP extension agent for the following crops

Maize (sole) .... kg Type ....

Cowpea (sole) .... kg Type ....

Maize/Cowpea (mixed .... kg Type ....

(b) What fertilizer dozes are you using for the crops

Maize (sole) .... kg

Cowpea (sole) .... kg

Maize/cowpea (mixed) .... kg

Others .... kg

(26) Why are you using less than the recommended fertilizer

level for the crops (if applicable).................

(27) Does using too much fertilizer cause weeding problems on your farm? ( ) yes ( ) No

(28) Please complete the following table

Crop	Area	FERTILIZER Ty.	Qua. kg	Sou.	Cost N	SEED Var.	Sou.	Cost N	CHEMICALS Ty.	Qty kg	Sou.	Cost N
Maize												
Cowpea	B1		B2		B3							
Maize/ cowpea												
sorghum												

(ii) Labour Record

(29) What is the source of labour on your farm

( ) Hired labour ( ) Family labour ( ) Hired and family labour

(30) Employ labour for

( ) clearing land ( ) planting seed ( ) weeding

(31) ( ) Applying fertilizer ( ) Harvesting

(32) How many of your family members work with you on the farm

(a) Full-time male .... Female ....

(b) Part-time male .... Female ....

(33) (a) How many hours do you work on your farm in a day

.... hours

(b) How many days in a week do you work on the farm

.... days

(34) What is the present wage rate for hired labour in your area N ....

(35) Please complete the following tables:

Crops/Crop mixture	Machinery Used	Labour Hired (No)	Unit of payment per hr. or per ha or per manday	Cash Equi-valent	Additional Payment e.g food
(a) <u>Maize</u>					
(i) Land prep./ Ridging					
(ii) Fertilizer Application					
(iii) Weeding					
(iv) Harvesting					
(b) <u>Cowpea</u>					
(i)					
(ii)					
(iii)					

(iv)

(c) <u>Sorghum</u>

(i)

(ii)

(iii)

(iv)

(d) <u>Maize/Cowpea</u>

(i)

(ii)

(iii)

(iv)

(e) <u>Other Crops</u>

(i)

(ii)

(36) Sales Record

Crop/Crop Mixture	Out Put (kg)	Quantity Soil (kg)	Value N	Market Source
(i) Maize				
(ii) Cowpea				
(iii) Maize/Cassava				
(iv) Maize/Sorghum/ Cassava				
(v) Maize/Melon				

III. Decision Making Variables

(37) From your experience for the past 10 years, which crop are risky in terms of variability in returns generated

................, ..., ...,

................, ..., ...,

(37b) What are risky situations on the farm

....

....

(38) What are the worst outcomes of your crops for the past 10 years

Crops	Worst (Production kg)	Acres Planted	Income Realised (N)
Maize			
Cowpea			
Sorghum			
Maize/Cowpea			
Cassava			

(39) What methods do you use to avert these worst outcomes in future ....

....

(40) That are the causes of such worst production and variations in output of your crops ....

....

(41) What step can be taken by ADP or Government of Minimize such variations in output and income of farmers

....

....

(42) What assistance do you receive from ADP

( ) Loans ( ) Tractor Hiring

( ) Technical Assistant (specify) ....

( ) Training Programme

(43) (a) Have you received any training from the ADP

(b) If yes for how long was the training ....months

(44) In what ways has your village benefited from ADP ....

....