RISK AVERSION BY SMALL FARMERS

- CAN IT BE MEASURED ?

Results of a survey of 69 small farmers in Kabare Location, Kirinyaga District, March 1977.

by

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ABSTRACT.

Small farmers in developing countries have to contend with many risks. One of the most important is the risk of less than adequate rainfall. Risk aversion by farmers can be a constraint on the transition from a subsistence to a cash economy.

This paper describes a survey of small farmers in Kabare Location, Kirinyaga District, Kenya which was conducted during March 1977. Results of the survey were used to attempt to measure the farmers' risk aversion. An index of risk aversion was constructed and used to test hypotheses concerning the characteristics of more and less risk averse farmers. The area of the survey fell into three distinct ecological zones, and the most significant result was the striking interzonal difference in mean values of the index of risk aversion, with farmers in the lower zones being progressively more risk averse. Other results were that

(a) In the upper zone, farmers with a smaller regular workforce tended to be more risk averse. This was also true to a lesser extent in the middle zone.

(b) In the middle zone, farmers who had attended Farmers' Training Centres were less risk averse. Also farmers on divided farms were <u>less</u> risk averse.

(c) In the lower zone, farmers who had attended other training apart from at school or Farmers' Training Centre were <u>more</u> risk averse. Also farmers who grew a high proportion of mixed crops were <u>less</u> risk averse.

Risk aversion seemed to play a more important part in decision-making in the lower two zones. In the upper zone, the farming was more commercial, and there was little rainfall risk.

It is hoped to refine the technique of constructing the index of risk aversion, and that it may be useful in future research in agriculture in developing countries.

Some implications of the study for policy decisions are discussed.

CONTENTS

CHAPTER ONE

LITERATURE REVIEW

A. The nature of risk in agricultural production

Agriculture as an occupation is subject to many uncertainties, because some degree of exposure to natural factors: heat, sunshine, moisture, rainfall, plant nutrients, soil properties, is inevitable. (Das Gupta) The stochastic variables: weather, market forces, lead to variations in yield, commodity prices in domestic and foreign markets, factor prices, and consequently to fluctuations in farmers' net earnings. In a diversified economy, variation in income may also be caused by competing or complementary interactions between enterprises. (Odero-Ogwell 1974). Uncertainty therefore plays a role in explaining existing cropping patterns. Uncertainty also occurs in marketing and expansion of production. Thibaud (1971) gives the additional factors of flood and revolution, as sources of risk in Argentina, and asserts that the producer's skill lies in taking the least risks necessary to make the maximum profit.

Agricultural production in developing countries is characterised especially by very large fluctuations in both prices and in physical outputs of agricultural commodities. This instability is caused by the extreme dependence of agricultural production on the weather, the high cost of storage and inadequate transport facilities, inelasticity of demand, and government regulations which often intensify the isolation of markets. (Nowshirvani 1971).

A basic distinction relevant for the decision - making framework of the subsistence farmer is between (i) those future events to which he can assign probabilities based upon past experience or personal knowledge and (ii) those future events to which he cannot assign probabilities, or where the probabilities offered are not derived from his personal experience but are based on external knowledge provided by others. (Wharton 1969) Following Knight (1933) case (i) is termed risk and case (ii) uncertainty, although the terms are usually used fairly loosely and interchangeably in the development literature.

Risk is often perceived by farmers as being more formidable in new technologies emanating from agricultural research than in more traditional practices. Consequently, risk may tend to act as an impediment to adoption of improved practices (Anderson 1974). The actual adoption of an innovation depends on the individual producer's risk preference and time horizon of planning. A subsistence farmer whose output is close to minimum living standard levels must be concerned not only with the most probable level of output using a new method or crop, but also with its range of variability. If he thinks it has a chance of leaving him below his minimum level then he will not try it. (Wharton 1969). Research and extension workers in agriculture may wish to identify technologies that are not only improved (more productive and profitable on average) but also less risky in that they would be preferred by risk-averse farmers.

However, technical innovation can greatly reduce the importance of uncertainties arising from natural factors. (Das Gupta)

Risk elements thus have an impact on existing techniques, selection of crop alternatives and the willingness of farmers for new capital inputs. An understanding of the nature of risk and uncertainty as it affects small farm production is an essential ingredient of rural development planning. The probabilities that minimum expected returns will fall short of a given specified level provide useful information in farm planning problems where consideration of subsistence or similar income levels is crucial.

The accepted wisdom about risk found in much of the agricultural development literature embodies the following argument: Traditional agriculture is efficient in the profit-maximising sense in allocation offactors of production (Schultz). Development necessitates new techniques and inputs which are viewed by farmers as risky. Farmers are risk-averse, and risk is therefore an important impediment to development (Vicente 1969). However there exists only mixed support to hypotheses of profit-maximising behaviour by farmers in traditional agriculture. Scope remains for investigation of the alternative hypothesis of utility maximisation which, unlike profit maximisation, explicitly allows for subjective risk considerations and might therefore provide a more realistic basis for policies aimed at modernising traditional agricultures. Dillon and Anderson (1971) contend that the traditional line of argument as given above may over-emphasize risk aversion.

Attitudes to risk, as measured by degree of preference or aversion, will vary both among farmers, and for one farmer, among different levels of expected profit. They hypothesise that risk is not a negative influence for all producers; and attitudes of risk preference may have played an important role, for example, in catalysing recent adoption of new crop varieties in some parts of Asia. In the view of these authors, quantitative information on risk attitudes must be an important element in understanding farmer behaviour in under-developed agricultures. Such quantitative information could readily be obtained via estimation of farmers' utility functions. These utility functions will be nonlinear if subjective risk is an important consideration for the farmer, in which case he would try to maximise expected utility rather than expected profit. A nearly linear utility function would mean he was facing little risk.

There is very limited quantitative evidence on the role of risk in developing agriculture. More attention to quantitative assessment of subjective risks seen by such farmers would aid the formulation of more efficacious development policies. Martin Upton has described some of the precautions which farmers may use to hedge against risk.

(1) <u>Choice of reliable enterprises.</u> The more reliable enterprises or varieties of crops and livestock may be chosen in preference to those with highly variable yields, even when the latter give a higher return on average.

(2) Diversification. Here several crops are grown together and perhaps livestock kept too, in the hope that these enterprises will not all fail together. This strategy has the effect of reducing risk only if the yields of the various enterprises are not positively correlated. Mixed cropping is a common form of diversification in Africa. Here drought-resistant crops (e.g. sorghum, millets, cassava) are planted together with preferred foods, to ensure that some return is obtained from the effort put into land preparation.

(3) Keeping reserves. Reserves of food are subject to possible deterioration and loss. Cash savings are the most flexible type of reserves. Another aspect is the employment of reserve capacity: (more labour or machinery than is needed in a typical year is employed in order to be prepared for the occasional year when cultivation conditions are difficult.)

(4) Maintaining flexibility. e.g. by using temporarily hired labour rather than regular workers, or by using any kind of labour rather than specialised machinery, or by hiring, rather than buying, machinery or oxen.

(5) Contracting prices in advance occurs where producer prices of the main crops are announced before planting time, or co-operative societies announce prices in advance.

(6) Staggered planting will ensure that some of the crop emerges whether the rains are early or late, and so will avoid wasting all the seed if the rains are very late.

(7) If farmers have a choice, they will often choose fragmented farms, on different soil types, rather than a consolidated holding, again to spread the risks.

The above, and other methods of risk aversion are likely to incur a certain cost of reduction in profit, but to provide greater **security**. Recent papers on the situation of low-income farmers have hypothesised that crop-planting decisions at the beginning of a particular season are based on avoiding risk. The subsistence farmer focuses on short-run goals such as achieving a minimum income in planning his crop allocation, but there is a behavioural **kink** at a critical income level. (Kunreuther and Wright 1974). This income - floor model is **especially** relevant for describing the behaviour of the subsistence farmer, whose cropping pattern is strongly influenced by a concern for having a large enough return from his land to feed his family for another year.

There exists empirical evidence that in developing countries, the element of risk and uncertainty caused by very large fluctuations in both prices and yields leads to a diversity of cropping which cannot be explained entirely by heterogeneity of land or the need to spread labour inputs over the entire year. Since incomes from different farm enterprises are not perfectly correlated, diversifying may provide some insurance against risk. Alternative cropping patterns provide different combinations of expected returns and riskiness. The final choice of crop mix will depend on the farmers' attitude to risk and the trade off between variance of returns and mean values. (Nowshirvani 1971).

The theoretical effort devoted to overcoming the assumption of perfect knowledge of the future in the theory of the firm has also been directed to the programming models used in farm planning, mainly in economically developed countries. Most empirical studies of farmers' behaviour under uncertainty have dealt with advanced economies, and the monetary returns from alternative cropping patterns. However there is a paucity of work on evaluating the nature of risk associated with planning projects at the individual farm level, and investigating the correlation between a farmer's attitude to risk and his farming decisions.

The combination of farm enterprises obtained by solution of a linear programming model may provide the maximum expected income under given constraints, but there is a variability from year to year and a degree of uncertainty from one year to the next that might be unacceptable to the farm operator (How and Hazell 1968). Thus there can be a big discrepancy between the optimum solution and the observed cropping pattern, and the problem is how to adjust farm plans to allow for unpredictable fluctuations in gross margins (gross returns minus variable costs) which result from uncertainty in activity yields, costs or prices (Hazell and How 1970). Optimum enterprise combinations can be calculated for different levels of risk aversion (measured in terms of variabilities of gross margins)(Kliebenstein and Scott 1975).

Thus before adequate evaluation can be made of policies which create new degrees of risk for agricultural producers, better quantitative knowledge is needed of how farmers will respond to changing risk in adjusting inputs and production decisions (Just 1975),

A few examples of empirical work on risk and uncertainty in agricultural production in economically developed countries will now be mentioned before looking in more detail at recent work which has been done in developing countries (see Section C). Love (1968) estimated variations in yield, prices received by farmers and gross income per acre for 13 census divisions in Alberta during 1946-1966 for the crops barley, oats and wheat. Boisvert and Jensen (1973) built a farm planning model that included data on time available for field work and on yield losses associated with untimely field and crop operations. They applied the model to eight hypothetical farm situations representative of maize and soybeans farming in South-Central Minnesota.

Francisco and Anderson (1972) investigated the attitudes of managers in a high-risk pastoral area (West Darling region of New South Wales, Australia) to uncertain prospects. All the 21 surveyed pastoralists were non-indifferent to risk, having non-linear utility functions for gains and losses.

Moore and Snyder (1969) investigated risk and uncertainty in lettuce production in Salivas valley, California. They found that for these small producers, in order to increase gross farm income, a large variability in income had to be accepted. The growers in the area appeared to have a subjective measure of the risk involved in different crops, and to diversify their crop programmes and select contractual arrangements accordingly.

Horiuchi and Fukuda (1971) took a cash crop upland farming area in Hokkaido, Japan, where miscellaneous high-profit but unstable and low-profit but stable crops were grown. They evaluated one method of risk-programming (the Heady-Candler Model) by comparing the relationship between the farm plans it gave and four representative farmers' behaviour in selecting crops or enterprises. They concluded that specific combination of crops is one of the most important means to avoid risky situations in upland farming.

Nieuwoudt (1972) examined the degree of uncertainty and risk involved in South African farming by analysing the variability of production figures and product prices, allowing for regional differences. Some important crops were compared from the point of view of risk. He found that the risk attached to production, prices and income was considerably higher for field crops than for livestock enterprises. The risk attached to gross income was greater than that attached to production, while uncertainty about product prices was greater than that for factor prices.

B. Techniques for incorporating risk and uncertainty into farm planning

Most of these techniques have been developed in the economically more advanced countries. In many cases the work has been purely theoretical and the method remains to be fully tested empirically.

Beginning with the work of Friedman and Savage (1948),and later with Markovitz and Tobin (1959), risk aversion became a subject of wide interest in economics. Kunreuther (1972) has applied this standard analysis of portfolio selection to the farm situation, using variance as the sole measure of uncertainty. He explicitly shows under what conditions the farmer wants to diversify his land even if it is homogeneous, and assumes an income floor is critical in determining how much of each crop is planted.

Since the work of Markovitz and Tobin the fundamental justification of risk aversion has been firmly linked to utilitarian economics (Just 1974). Rather than being a profit-maximiser, the farmer is assumed to maximise his expected utility. Officer and Anderson (1968) argue the inappropriateness of all other hypotheses concerning farm management decisions and contend that expected utility analysis is an operational tool for decision making under uncertainty and can also be used to guide effective advisory work (see also Wolgin 1973, Lin 1973, Morris 1974).

Stemming from this there have been several attempts to derive utility functions for individual farmers. Notable among the literature are the contributions of Officer and Halter (1968); Makeham, Halter and Dillon 1968; Vicente 1969; Dillon 1971; Francisco and Anderson (1972) and Webster and Kennedy 1975. These attempts have been for farmers in the U.S.A. or Australia. The approaches used are termed Von Neumann-Morgenstern (modified or unmodified) and Ramsey. Dillon (1971) reviews these methods. The 'standard reference contract' or Von-Neumann - Morgenstern method is based on the concept of certainty equivalence. If outcome x_1 is preferred to x_2, and x_2 is preferred to x_3, then there exists a probability p such that

$$p\ U(x_1) + (1-p)\ U(x_3) = U(x_2)$$

For specified values of x_1, x_2 and x_3; the utility of x_2 can be determined by questioning to find the value of p at which x_2 is the certainty equivalent of the risky prospect involving x_1 and x_3, $U(x_1)$ and $U(x_3)$ being given values on an arbitrary scale. By finding the values of p corresponding to an array of values of x_2 between x_1 and x_3, the utility curve may be plotted for values of x from x_1 to x_3. This unmodified Von Neumann-Morgenstern approach may be criticised on two grounds. First, if the subject has a liking or disliking for gambling per se, his certainty equivalents may be influenced by this bias, since the questions posed involve a risky prospect versus a sure prospect. Secondly, bias may be introduced if the subject has preference for some probabilities per se over others, or if he does not understand the concept of probability.

The modified Von Neuman Morgenstern method uses neutral probabilities of $p = 0.5 = 1-p$ to overcome the problem of probability preference. Questions are posed to determine the certainty equivalent x_2 for a 50-50 or even-chance prospect of x_1 or x_3, arbitrary utilities $U(x_1) > U(x_3)$ again being set for x_1 and x_3. Thus we have

$$U(x_2) = 0.5\ U(x_1) + 0.5\ U(x_3) = U(x_2)$$

In a similar fashion, the certainty equivalent may be established for the 50-50 prospect of x_1 and x_2, say x_4, which will have a utility of

$$U(x_4) = 0.5\ U(x_1) + 0.5\ U(x_2)$$

and for the 50-50 prospect of x_2 and x_3, say x_5, which will have a utility of

$$U(x_5) = 0.5\ U(x_2) + 0.5\ U(x_3)$$

By further linked questions, additional points on the utility curve may be established. While the modified Von Neumann- Morgenstern method overcomes bias due to probability preferences, it is still open to the criticism of involving choice between a risky and a certain outcome. The Ramsey method aims to overcome both criticisms of the 'standard reference contract' approach. It involves a sequence of choices between linked pairs of 50-50 gambles. The only comparative test of the above three indirect procedures for obtaining the utility function appears to be that of Officer and Halter. They concluded that the modified Von Neumann-Morgenstern and Ramsey procedures were better than the standard reference contract approach, most consistent results being obtained by the Ramsey method but at the cost of more complicated questioning. Other results suggest that the modified Von Neumann-Morgenstern method is generally quite satisfactory.

There have been two principle approaches to the introduction of uncertainty conditions into programming models. (Fanfani 1973)

(a) Stochastic programming models, which no longer consider the various model parameters as fixed, but as stochastic coefficients.

(b) Programming models formulated according to decision theory, introducing criteria of choice into a linear programming model.

The latest theoretical developments tend to combine several important characteristics of both these approaches. It remains to consider each main group of these programming models briefly in turn.

(i) Quadratic programming attempts to simulate decision-making in a risky environment by incorporating variability indices as measures of risk. Thus quadratic programming finds the 'E-V' frontier, that is, for a given expected value of farm income, say, it minimises the variance, or for a given variance it maximises the expected value of farm income. This modification of the linear programming solution may lead to a marked reduction in income variance at the cost of only a small sacrifice in expected net income. Quadratic programming is a useful tool to help identify such adjustments for a complex farm business.

Bauer (1971) developed a quadratic programming algorithm for deriving efficient farm plans in a risk setting. Scott and Baker (1972) used quadratic programming to calculate the variance - efficient mean income path . and associated lower income bounds, and suggested a way to select an optimum farm plan under risk based on the farmer's own self-assessed income-risk preference function. However, a practical limitation of quadratic programming is the data required for estimation of the necessary variance-covariance matrix. The need to obtain data for a long enough period, with trends and cycles removed, leads to major analytical problems. (How and Hazell 1968) A further criticism is that although quadratic programming may approximate the farmers' attitude towards risk, it will not necessarily conform to their subjective decision-making behaviour (Odero-Ogwell and Clayton 1973) but it does introduce more realism into the model than does linear programming.

(ii) <u>Parametric linear programming (adaptions of linear programming).</u> Linear programming has been criticised as a farm management aid because it fails to make explicit allowance for variation in price or input-output coefficients. However, because of the limitations of quadratic programming mentioned above, together with scarcity of computer time, some method of incorporating risk considerations into a linear programming framework is desirable.

Even minimum subsistence constraints in a standard linear programming model reflect some degree of risk aversion (Odero-Ogwell and Clayton 1973). One linear alternative which retains most of the theoretically appealing features of quadratic models uses the mean absolute deviation to derive efficient 'E-V' farm plans. (Thompson and Hazell 1972) This method has been used by Schluter (1974). It can also be used when a computer code for quadratic programming is not available. Other measures of income uncertainty used by Hazell (1971) are the Wald maximin and the Savage regret criteria. His linear technique was originally developed to handle uncertainty in activity gross margins while ignoring uncertainty in the farm constraints, but an attempt was also made to generalise the models to handle simultaneous uncertainty in activity gross margins, activity resource requirements and in the total farm resource supplies.

Another extension of linear programming is variable price programming, the results of which can take the form of price mapping, which provides a clear picture of the stability of the optimum plan to variations in prices of the major products (Glau and Luders 1968).

(iii) <u>Game theory and statistical decision theory</u>

This includes the idea of a "game against nature" where "nature" is used as a term for conditions not under the control of a decision-maker. The game against nature includes (a) alternative courses of action for the decision-maker (b) possible occurrences of "states of nature" and (c) the payoff matrix in which the elements indicate outcomes or results of each possible action for each possible state of nature. (Stryg 1970).

The strategy chosen may depend on the decision makers' risk aversion, economic situation, psychological attitude etc. Different decision models include the Wald maximin criterion theory, Hurwicz pessimism-optimism index, Savage regret criterion, Laplace insufficient reason, Simon's satisfier theory, Shackle's theory (Gutierrez 1967).

Game theory models have also been applied to agricultural production by Agrawal and Heady (1968). Rook (1970) examines decision techniques and other game theory models in farm planning under risk or uncertainty.

A related approach to farm planning under uncertainty is maximin programming (McInerney 1967) McInerney shows that each decision criterion can be incorporated into a linear programme model in such a way that the solution satisfies both decision rule constraints and resource constraints imposed on each planning problem. The emphasis is laid on the application of the maximin strategy as an optimum criterion is a Linear Programme model, so that the optimum is achieved by maximising the minimum possible level of total gross margin. This figure is denoted maximin return, which is considered as a measure of risk. The larger the maximin return (for a given expected total gross margin) the smaller the risk (Stryg 1970). Mattei and Turrie (1973) make an empirical analysis of a capitalistic farm engaged in cereal and livestock production, deriving the most advantageous short-term programme using the game against nature theory and a weighted maximin and maximax decision criterion. Webster and Kennedy (1975) use a model which maximises expected returns subject to a given probability of ruin (Shackle's focus of loss). Sets of indifference curves are constructed for farmers willing to forego expected income for increases in a probabilistically-defined minimum income.

Hazell and How (1970) show that approaches such as the above differ primarily in the assumed decision criteria but that the relations between them have not been fully explored. Utilising various decision criteria, a general class of short-run farm planning models can be developed, that have in common an expected (forecasted) income and a measure of income uncertainty. They generate a set of efficient farm plans for the range of all possible expected incomes, such that the measure of income uncertainty is minimised for each expected income level, and for each level of income uncertainty, the expected total income is maximised.

Hazell (1970) points out that current game theoretic models for farm planning are limited in scope and restrictive in assumption, and that the desirable features of the game theoretic and quadratic programming approaches can be combined by parametric linear programming.

Low (1974) indicates a weakness of the game theoretic approach to be arbitrariness in measuring various factors. He assumes that farmers wish to maximise their mean income under the constraint that the total focus loss of the cropping plan is at least equal to the difference between the mean income of that plan and the minimum income required to avoid ruin. He employs game-theoretic decision criteria ('minimum cost of security' criteria) which minimise the cost of providing against ruin. This variation also is incorporated into a standard linear programming framework, requiring not much more data than is needed for ordinary linear programming.

Tadros (1970) proposes a model for farm planning under uncertainty which uses games theory and linear programming, and applies it to a cash crop farm in New York State. The states of nature for this game represent different possible combinations of gross margins of the farm activities (activities in the linear programming sense) which might occur in the planning period ahead. The farmers' strategies are defined by various combinations of farm activities i.e. farm plans, and these and the payoff matrix are derived by a deterministic linear programming model. Both pure and mixed strategy solutions are allowed, and both technical uncertainty and price uncertainty are considered.

The above are the three main groups of techniques used to derive farm from plans under risk or uncertainty. A few less well-known variants will now be mentioned.

Just (1975) gives an alternative explanation of risk averse behaviour for the firm based not on utility maximisation but rather on expected profit maximisation. He considers production where both price and quantity are stochastic, but notes that, in contrast to the usual expected utility maximisation framework where variations both in price and quantity can be important, profit maximisers are sensitive only to quantity variability. Just also reviews two existing approaches (the normative or programming approach and the positive or econometric approach) for estimating the effects of changing risk in agricultural supply response. In an earlier paper, Just (1974) presents an empirical investigation of the importance of risk in farmers' decisions, generating the adaptive expectations geometric lag model by geometrically including quadratic terms indicative of risk. The model is applied in the analysis of California field-crop supply response.

Anderson (1974) uses the concepts of stochastic dominance to attempt to identify improved technologies which are less risky in the absence of knowledge of the farmers' individual attitudes to risk. In another paper he investigates the minimum data required for a reasonable estimate of probability distributions through a Monte-Carlo study of a rule for smoothing sparse data into cumulative distribution functions. In a set of estimated distributions, risky prospects not preferred by risk-averse decision-makers can be identified and discarded. A similar method was developed (Anderson 1973) for assessment of risk in crop response processes when only a few data were available. The optimal inputs depend on the degree of risk-aversion when controlled inputs influence risk.

Simulation is also used by Sadan (1970) to investigate the investment behaviour of a farm firm operating under risk. Thompson and Hazell (1972) conduct a Monte-Carlo simulation study to test the accuracy of a linear programming approximation using the mean absolute deviation to derive efficient E-V farm plans when a suitable quadratic programming computer code is not available.

Thomas, Blakeslee, Rogers and Whittleseyn (1972) propose the use of separable programming for selecting farm enterprises which are efficient in terms of expected income and income variance, and give an empirical application.

Yaron and Horowitz (1972) give a sequential programming model of growth and capital accumulation of a farm under uncertainty. This includes treatment of uncertainty in terms of eliminating plans which may lead to severe failures (bankruptcy) at any sequentially conceivable state over the planning horizon. In a later paper (1973) they integrate linear programming and decision tree analysis to treat short and long-run farm planning under uncertainty. The attitude towards risk of the farm operator is expressed in the willingness to maximise the expected value of the income stream over the planning horizon, subject to the restriction that alternatives which may lead to lack of liquidity must be eliminated.

Lexicographic utility analysis is used by Kunreuther and Wright (1974), Barry and Robison (1975), Lin (1974) and Roumasset (1974)., who develops two lexicographic ordering models based on the multiple goals of security and expected profits, for Philippine rice farmers. Kunreuther and Wright stress the importance of short-run goals in determining the subsistence farmers' crop allocation.

Chen and Baker (1974) propose a dichotomous 'marginal risk constraint' to take explicit account of activity income covariance and to restrict the choice of activities within the range of rational combinations.

Ethridge, White and Kannon (1975) develop a theoretical framework for optimising planted acreage under yield and utilisation uncertainties; the objective function being expected dis-equilibrium cost, which is the extra cost involved if actual production is greater or less than actual utilisation of the crops. They give an empirical application for groundnut seed acreage in Georgia.

C. Studies on risk and uncertainty in agriculture which have been carried out in developing countries (not including Kenya)

Nowshirvani (1971) developed an allocation model which took account of the price and yield of a food crop and a cash crop, the amount of food and manufactured goods consumed and the proportion of land devoted to food crops, and assume that the objective was to maximise consumption. He concluded that there was a basic difference between response for cash and food crops, and that inclusion of uncertainty made the direction of the area-price response ambiguous. He thus showed that government price stabilisation programmes may have a perverse effect when crop production is primarily for self-consumption.

Lipton (1968) in a study of farmers in an Indian village found security to be profit-constraining. For example, because of soil erosion and drought it paid the farmer to sow less millet per hectare and to add robust drought-resisting but less profitable bean sprouts.

Kahlon and Sharma (1968) examined decision in allocating area to different crops in a random sample of 648 farms in the Punjab, in the light of risks and uncertainties (of soil subject to floods and waterlogging, tenurial arrangements and yield uncertainties). They found that farmers seemed to restrict the acreage under crops with more uncertain yields.

Some earlier work based on empirical data for India attempted to assess the factors that caused risk and uncertainty and to study its impact on resource allocation by farmers in developing countries. The majority of farmers had been guided in crop planning by high gross returns, low variability of gross returns and low price variability. The factors of uncertainty differed in different regions but the general impact of uncertainty had driven the farmer to opt for diversification in crop combinations and livestock keeping (Papers in Indian Journal of Agricultural Economics 1964).

Das Gupta employed quadratic programming to investigate the rationality of peasant decision-making in Indian agriculture and found that peasant farmers' responses, although sub-optimal, were in fact compatible with profit-maximising behaviour.

Schluter and Mount (1974) examined empirically the cropping patterns chosen by a group of peasant farmers in Surat district, India, using a simple model of risk aversion. The data showed that the observed behaviour corresponded very closely to the hypothesis that farmers allocate land to different crops by striking some balance between the competing criteria of increasing income and decreasing risk measured by income variability. The actual definition of risk used was the mean absolute deviation of income around its mean level. Schluter (1974) considered the interaction of credit and uncertainty in determining resource allocation and incomes on small farms in the same district of India. He gave special emphasis to small farmer response to risk and uncertainty, using a programming model to measure risk and uncertainty effects.

Kunreuther and Wright (1974) explicitly postulated that the subsistence farmer focuses on short-run goals such as minimum income in planning crop allocations, and applied the model they developed to explain the patterns of choice between jute and rice in Bangladesh (as well as between cotton and maize in the U.S. South in the nineteenth century).

Hiebert (1973) proposed and tested hypotheses concerning attitude towards risk among low income farmers using data for Philippine rice farms as well as presenting and testing several hypotheses about sources of agricultural risk. Gutierrez (1967) also took the case of Philippine rice farmers, pointing out that Philippine agricultural development was among the most advanced in Asia and yet the national average in rice production per hectare was one of the lowest. He used different decision models for rice farmers' decision-making under uncertainty and found a tendency for Philippine rice farmers to be 'minimisers of maximum expected regrets'.

Cancian (1972) showed the important influence of uncertainty on decisions made by farmers in response to new economic opportunities provided by Government programmes. A theory relating behaviour under uncertainty (as opposed to risk) to rank in an economic stratification system was developed and tested.

Vincente (1969) in a study of 47 Chilean farmers' utility functions over a range of money gains to three times the annual net income, found only 4 to be approximately linear and 12 to exhibit strong risk-preference.

Low (1974) presented a method for taking uncertainty into account when representing the production decisions of near-subsistence farmers. He assumed that farmers maximised expected income subject to meeting yearly subsistence requirements in adverse conditions. A game theoretic criterion was employed to minimise the cost of securing subsistence requirements under uncertainty. The results of incorporating the formulation into a linear programming model of peasant farming in S.E. Ghana indicated that the assumption made as to farmers' objectives was valid for the situation studied, and he suggested that farmer behaviour observed elsewhere in Africa might be explained in similar terms.

The above studies have mainly been concerned with assessing the nature of risk and uncertainty in agriculture and its impact on agricultural production. Some other work has been concerned particularly with the riskiness, real or apparent, attached to the adoption of technological innovations. Schluter and Parikh (1974) used survey data to demonstrate the importance of co-operative credit for the adoption of a high yielding variety of rice, which was highly uncertain, whereas for a less uncertain high yielding variety of wheat, co-operative credit seemed not to be important for adoption,

Roumasset (1974) estimated the risk of alternative techniques of nitrogenous fertilisation of rice in the Philippines by combining experimentally - determined production functions with cross-section data on crop damages, and concluded that farmers' reluctance to use modern techniques might not be due to their aversion to risk. A risk - neutral

(i) <u>Structure of the Sample</u>

Name of Sub-location	Total Number of land titles in sublocation
Nyagithuchi	111
Njiku	470
Gachige	533
Mutige	285
	1399
Ngiroche	468
Kiritine)	778
Rukenya)	
Mikarara	177
	1423
Ndomba)	950
Nyangati)	

(ii) <u>Zoning</u>

<u>Zone 1 (Upper)</u>

Nyagithuchi

Njiku

Gachige

Mutige

Proportion of total number of land titles in Kabare Location	Number of farms in sample	Proportion of total number of farms in sample
0.03	3	0.04
0.12	8	0.12
0.14	8	0.12
0.08	5	0.07
	24	
0.12	8	0.12
0.21	13	0.19
0.05	3	0.04
	24	
0.25	21	0.30

Zone 2 (Middle)

Ngiroche

Kiritine

Mikarara

Rukenya

Zone 3 (Lower)

Ndomba

Nyangati

TABLES OF RESULTS.

Results of the questionnaire, a copy of which is enclosed inside the cover.

These should be read in conjunction with the text of chapter 4, pages 40 - 81

(iii)

Person interviewed	Zone 1	Zone 2	Zone 3	Total
		Number of farms		
Owner	10	13	8	31
Only wife	7	4	7	18
Owner and only wife	2	4	2	8
One of several wives	1	0	1	2
Widowed only wife	1	1	1	3
Widowed one of several wives	1	0	1	2
Son	1	1	1	3
Daughter or daughter in law	1	1	0	2
Total	24	24	21	69

(iv)

Possession of another farm	Zone 1	Zone 2	Zone 3	Overall
Number of farmers	2*	8	7	17
Proportion of farmers	0.08	0.33	0.29	0.25
Mean acreage of the other farm	6.5	4.4	14.4	8.7

*One of these farmers owned two other farms.

(v) (a) <u>Acreage hired from others</u>

Number of farmers who hired land from others

Proportion of farmers who hired land from others

Mean acreage hired

(b) <u>Acreage hired to others</u>

Number of farmers who hired land to others

Proportion of farmers who hired land to others

Mean acreage hired

Zone 1	Zone 2	Zone 3		Overall
1	1	1	1976 short rains	3
		3	1977 long rains	5
0.04	0.04	0.05	1976 short rains	0.04
		0.14	1977 long rains	0.07
1	3	5	1976 short rains	3
		3.8	1977 long rains	3.1
0	7 1976 short rains	5		12
	6 1977 long rains	4		10
0	0.29 1976 short rains	0.24		0.17
	0.25 1977 long rains	0.19		0.14
-	4 1976 short rains	3.4		3.75
	3.8 1977 long rains	3.9		3.85

model predicted as well or better than a model incorporating risk aversion for the farm areas considered. Using the amount of nitrogen fertilizer which maximised expected profits did not substantially increase the risk above the low nitrogen levels. A comment on Roumasset's paper suggested that farmers might be reluctant to adopt innovations such as using nitrogenous fertilizers which they viewed as risky even if in fact the innovation did not increase risk.

Hiebert (1974) also used empirical evidence from the Philippines, to examine the effect of uncertainty due to imperfect information on the decision to adopt fertilizer-responsive seed varieties, Additional information and enhanced ability to 'decode' information were shown to increase the likelihood of adoption. In an earlier paper (1973) he characterised technological uncertainty by a random variable in the firm's production function.

Rathod (1973) took the case of sugar-cane production in Western Uttar Pradesh, India and put forward the hypothesis that if realised prices were always above the guaranteed price, the price guarantee would not affect price expectations or production. Its effect would be limited to serving as a form of insurance against price reductions which might, in turn, encourage farmers to take on risks more easily and incur debts in the adoption of new technology. Porter (1959) also investigated risk, incentive and the technique of the low-income farmer in India.

Drummond and White (1975) explored the factors explaining the low rate of investment in agriculture in developing countries. One hypothesis was that the return on such investments was high relative to both the cost of capital and the returns on such investments in economically developed countries, whereas investment in developing countries was subject to relatively higher risk. To test this hypothesis the variability in income streams caused by price and yield risks were investigated for a sample of farm firms in two regions of Brazil and one of U.S.A. An annual income series was simulated for each firm: risk was taken to be a function of the stream's variance. The empirical findings led to a rejection of the hypothesis. Low rates of investment in Brazilian agriculture relative to Indiana agriculture appeared to be attributable to relatively low rates of return rather than to high rates of risk.

Finally, a few studies are specifically concerned with the impact of irrigation on reducing risk and uncertainty. Nadkarni (1971) measured uncertainty in yield for 8 crops at the State level in India in terms of the deviation from the normal yield. At the State level uncertainty was strongly and negatively associated both with the proportion of the area irrigated and the annual rate of increase in yields.

Gangwar and George (1971) estimated the risks and uncertainties in crop production as reflected in yield, price and income variabilities, in Haryana State, India. They found that the districts with assured irrigation had lower yield variability and hence lower income variability. Further, the more paying crops such as sugar cane, wheat and maize, had greater variability in yield than the less paying crops, and hence the intensity of income variations also depended on the cropping pattern of the district.

Carruthers and Donaldson (1971) outlined an approach to assessing the benefits from investment in the irrigation of tea stands in three areas of Bangladesh. Since the biological and weather effects that determined annual and long-run productivity of the stand were stochastic variables, the evaluation was made using a simulation model in which these determinants were introduced as known discrete probabilities. Using this model, an estimate could be made of the net gains to a tea estate of the risk reduction achieved by eliminating harmful crop moisture deficits.

Nudds, Simpson and Bottomley (1973, 1974) showed how risk analysis using the 'Monte-Carlo' method could be used to determine a probability distribution for internal rates of return on a projected irrigation scheme.

The above studies, in developing countries have found irrigation to reduce risk. It is worth noting that El-Saadi and Swanson (1972) found that although investment in irrigation tended to increase the average level of annual net farm income and worth, risk, as measured in terms of statistical variance, also increased due to shifts in types of crops and less reliance on Government set-aside programmes. Their results derived from a simulation analysis of a large farm in Illinois.

D. Studies on risk and uncertainty in Kenyan agriculture

Heyer (1971, 1972) analysed the impact of cotton on a traditional food crop system in a semi-arid area of Kenya, using a linear programming model and sensitivity analysis. Alternative criteria: maximax, maximin and a standard average return maximand were used in turn and the solutions all evaluated as 'best year', 'worst year' and 'average' values. This gave a range of results that took account of the uncertainty in the farming situations.

Odero-Ogwell and Clayton (1973) used survey data from the Farm Economic Survey Unit of the Ministry of Finance and Planning to carry out regional programming for Nyeri District. The risk factor was defined in terms of yield and price variabilities over a 10 year period measured in terms of means and variances of gross margins of individual enterprises by district and ecology. Odero-Ogwell (1974) extended the analysis using quadratic programming, and comparing the results with those derived under the perfect knowledge linear programming assumptions. On the basis of income, production and employment, he concluded that more realism would be introduced in planning when tolerable risk aversion was allowed. Compared with linear programming, perfect knowledge and actual situations, risk programming results not only showed increased agricultural productivity and output but also considerable security to small farmers in terms of provision of sufficient food for minimum family subsistence and adequately diversified production to hedge against crop failure.

Wolgin (1973, 1975) developed a neo-classical model of farmer behaviour under conditions of uncertainty to determine the effect of risk on farmer behaviour, whether farmers are efficient in their allocation of resources, and how responsive farmers are to changes in the price vector He used data from the Small Farm Sample Costs Survey 1969-70 by the Statistics Division of the Ministry of Finance and Economic Planning. This was a stratified random sample, taken in the most important agricultural areas of Kenya, conducted by interviewers on a monthly basis. There were 1500 farms in the sample and information was recorded on 505 variables including land devoted to each crop, labour inputs by crop, capital stock, non-farm income, fertilizer inputs, wage rates, output prices at farm gate. Wolgin found that while farmers were efficient in the allocation of resources, they used too few inputs. This indicated that one of the big bottlenecks in smallholder agriculture in Kenya was lack of credit. He also found that risk plays a critical role in farmer decision-making and that consequently, the reduction of risk would have large payoffs in terms of increased expected return.

Gunawardena, Simpson and Wynne (1975) applied risk analysis to the appraisal of livestock projects. They noted that neglect of risk, especially of droughts and diseases, might have in the past led to an over-optimistic view of investment projects. Therefore there was a strong case, in their view, for using risk analysis, since investment capital was too vital a resource to be wasted.

Lynam (forthcoming Ph.D. thesis Stanford University) undertook an analysis of risk-bearing in medium-potential Kenyan agriculture (Machakos Division). The first aim was to conduct a farm enterprise survey to discover farmers' cropping practices, labour utilisation and land management in different rainfall zones and to provide a fuller understanding of smallholder farming in medium-potential areas. Also the resource constraints were analysed by looking in particular at the manner in which farmers respond to various levels of rainfall and rainfall risk. Finally he studied the interaction between different rainfall and ecological zones, particularly in terms of population and labour flows, commodity flow; drought adjustments and income distribution. The study looked at the effect of various levels of rainfall risk on the farmers' propensity to innovate, their trade-offs between the planting of higher-value crops and increased risk of drought loss, and their choices between subsistence and cash crops; thus perhaps providing an understanding of the constraints hindering further development of the medium-potential areas

Reference

Lynam, J.K. (1976) An analysis of risk bearing in medium-potential Kenyan agriculture. University of Nairobi, Institute for Development Studies, 'Research and Publications' (Jan. 1976) pages 28,29 .

CHAPTER TWO

Introduction - purpose of this study

Small farmers in developing countries have to contend with many risks. One of the most important is the risk of drought, or at least of unreliable rainfall. Yields from crop and livestock enterprises are highly dependent on the weather. Too much or too little rainfall, or its early or late arrival,may have severe consequences. In addition, crop pests and diseases can cause heavy yield losses. There are also risks attached to the adoption of new technology, fertilizers and seeds; and due to price fluctuations both of outputs and inputs.

Subsistence farmers often produce very small surpluses over their basic nutritional needs for their families. In such cases, any crop failure can jeopardise their very survival. For this reason, the farmers may be 'risk-averse'. Some authors argue that the main objective of such farmers is merely survival rather than profit maximisation. Risk aversion of farmers can therefore be a constraint on the transition from a subsistence to a cash economy in rural areas.

When deciding on a topic on which to write my research paper, I found the subject of risk and uncertainty in agriculture to be both academically interesting and practically useful for a developing country such as Kenya. I was mainly interested in some of the techniques described in 1(B) above for farm planning in a risky environment. However most of these require very sophisticated computer programmes which are not readily available here, not to mention the quality and quantity of data also needed.

Being somewhat sceptical of the quality of much of the data used in economic studies in Kenya, I decided I would prefer to collect my own data; this would also be a most worthwhile experience and give me much more first-hand feeling for the situation and problems of small farmers.

I wondered initially whether it might be possible to attempt to derive the utility functions for the farmers, using the Von Neumann-Morgenstern, (modified or unmodified) or the Ramsey approaches described above in 1 (B). However, I rejected this idea because the concepts of probability or gambling may be alien to some Kenyan farmers and even in economically advanced countries, there remains the problem of whether the answers to the question on gambling used in such an approach would correspond to the farmers' actions when confronted with a real-life decision problem under risk.

However, it was apparent from the literature reviewed above that only a small amount of research has been carried out on risk and uncertainty in developing countries, and a particular area of neglect was farmers' attitudes to risk in such countries. I therefore wondered if it would still be possible to discover something of the farmers' attitudes towards risk, not by direct means, but by deriving them from answers to open-ended questions on farming practices, and also from some basic factual information about acreages under different crops, crops bought and sold, assets, demographic data etc. I had to use information which could be obtained at a single interview, since the time constraint of 4 months for the completion of the whole research project would make it impossible for me to visit each farm in the sample several times.

The agricultural development literature gave such factors as proportion of land devoted to food crops (Nowshirvani, Kunreuther), degree of diversification (Nowshirvani), low adoption of improved technology (Roumasset) as indicative of the farmer's risk aversion. I therefore devised a questionnaire which would give me enough information to attempt to extract some measure of each farmer's risk aversion, and to test some hypotheses about the characteristics of the more and less risk-averse farmers. I chose an area which could be easily divided into three distinct ecological zones so that I could conduct a zonal comparison.

The objectives of the research project were therefore:

(a) To study risk and uncertainty, and how they affect small farm production in an area of Kenya.

(b) To compare their effects in areas of differing rainfall.

(c) To consider whether Kenyan small farmers in this area are risk averse or are risk-takers, and to discover the characteristics of some of the more-and less-risk-averse farmers.

The study is therefore empirical, based on the data of the survey, rather than theoretical; the hypotheses tested are simple. That this is so is largely because the organisation and conduction of the survey took almost half the time allocated to the project. It is hoped to present a more complete analysis of the data at a later stage.

CHAPTER THREE

Practical Details:

The first formality was to apply for a research clearance permit from the Office of the President, to conduct my survey in Kabare location of Kirinyaga District. Application was made on 22nd December 1976 and the research permit granted on 2nd February 1977. I had first visited the area in October 1976 but a preliminary visit before the survey was made on 11th/12th February 1977 to familiarise myself and to meet someone who had been suggested to act as an interpreter. During this time the questionnaire was being prepared. On 21st February I went to Kabare to conduct the pilot survey. Before I began I met the District Commissioner for Kirinyaga who was most helpful. During the pilot survey 13 farms were visited. These were not a truly random sample but it was ensured that several farms were visited in each Zone. The purpose of the pilot survey was to test the questionnaire and to give myself and the interpreter practice in interviewing. After this a few changes were made to the questionnaire

The survey proper was conducted on weekdays between 1st and 25th March, 1977. The 69 farmers visited were a random sample from Kabare location, stratified by sublocation, with approximately equal numbers in each of 3 ecological zones. The sample was picked, using random number tables, from lists of land holders at the Land Registry at Kerugoya. In order to have access to the title deeds, it was necessary to have a letter of introduction from the Chief Land Registrar in Nairobi. However this was only a formality once having obtained the research clearance permit.

Having made lists of the names and plot numbers of the farmers in the sample, the next problem was to locate the farms. This would have been extremely difficult using only very large-scale maps of the plots which could be seen at the Survey of Kenya Office, Kerugoya, since it was not easy to relate these to the roads on smaller-scale maps of the area. To overcome this difficulty the District Commissioner arranged for the Chief of Kabare to assist me. As long as I gave the Chief one or two days notice of which sublocation I intended to work in on a certain day, he arranged for the appropriate sub-chief of the sublocation to meet me at a particular trading centre, and to guide me to the farms to be visited that day. This arrangement worked extremely well, and the sub-chiefs were also helpful in introducing me to the farmers and explaining the purpose of the questionnaire, thus alleviating any fear or suspicion on the part of the farmers.

During early March the area was dry and the farmers were mostly not too busy as they were not quite ready to prepare the ground or plant their crops. We began at the Northern part (Zone 1) since the rains begin earliest there, and worked downwards. We noticed especially during the last week that the farmers were busier preparing the ground and planting, since the rains were beginning. Each interview ranged in length from just under an hour to almost two hours, the mean time taken being about 1¼ hours. The length of the interview depended on how fully the farmer answered the questions and also on the complexity of his farm. Some supplementary questions were asked relating to whether he owned or hired any other land and sometimes the answers were quite involved.

Three interviews in Zone 1 and one in Zone 2 were conducted mainly in English, the remaining 66 were conducted in Kikuyu, although occasionally there was a school leaver on the farm who spoke English. For nearly all interviews therefore, after I had asked each question in English, the interpreter translated it into Kikuyu, obtained the answer and translated it back to me. I had to ask each question because sometimes they had to be phrased slightly differently, or supplementary questions asked, depending on the circumstances. I then recorded all the answers.

Even later in March, most farmers were quite willing to spare the time to talk to us. We aimed to visit five farms per day: three in the morning and two in the afternoon. This could mean a working day of from 8. a.m. to 6.30 p.m. Usually we achieved this aim, although sometimes it was only possible to visit 4 farms in a day.

In general, one visit only was made to each farm. Usually either the husband or wife would be present and if neither was we would return later that day or the following day.

The interview was nearly always conducted at the farm but in 10 cases it was held elsewhere as shown in the table below:

Place of interview	Frequency
A neighbour's farm	2
Owner's duka (tea Kiosk)	2
School (farmer: school-teacher,cook)	2
Trading Centre	3
Owner's home at village	1
Owner's farm	59
TOTAL	69

In such cases the reason was that the owner worked, or else was usually found, away from the farm. However, since he was the person responsible for the farm, the quality of information obtained was unaffected.

A later visit was made to Kabare between 12th and 15th April to check on various details and obtain some more background information. For 5 farms there was an apparent discrepancy between the acreage quoted by the farmer and that in the title deeds, so the land register was checked. Also 9 farms were briefly re-visited to fill in any gaps in the data which had become obvious when checking the answers to questionnaires (For instance when another farm or hired land had been referred to but details about crops grown were lacking). At the same time, the following officials were interviewed.

Mr. James Njoroge, District Land and Farm Management Officer, Kirinyaga.

Mr. J.N. Nkanata - District Animal Husbandry Officer, Kirinyaga

Mr. Josphat Wambugu - Secretary/Manager Kabare Coffee Co-operative Society.

Mr. Z.S. Mumbere - District Co-operative Officer, Kirinyaga.

Chief Jotham Nguri- Chief of Kabare Location

Mr. Mutegi - Agricultural Finance Corporation Manager, Kerugoya.

These interviewed yielded much useful background information.

Thus the overall period of data collection amounted to 6 weeks. Next, the raw data from the questionnaires had to be transferred to large charts for ease of subsequent tabulation and calculation.

(More practical details, on the structure of the sample, zoning, the person interviewed, ownership and hiring etc. are given in the following chapter (Chapter 4)).

(c)	Zone 1	Zone 2	Zone 3		Overall
Mean charge K.Shs per season for hired land	40	73.3	77.1	1976 short rains	72.9
			91.4	1977 long rains	80.0

TABULATION OF ANWERS TO THE QUESTIONNAIRE

1 (a) Acreages of farms in the sample as given officially in the title deeds	Zone 1	Zone 2	Zone 3	Overall
Number of farms in the zone	24	24	21	69
Mean acreage	7.1	6.1	12.5	8.4
Standard deviation	5.3	2.8	5.8	5.5
Acreages of farms in the sample as stated by the farmers themselves				
Mean acreage	7.0	6.0	13.1	8.5
Standard deviation	3.5	2.8	5.3	5.0

	Zone 1	Zone 2	
		1976 short rains	1977 long rains
Mean acreage	7.3	5.9	6.1
Standard deviation	3.8	3.4	3.4

Acreage for which the family is responsible

= total acreage owned as stated by the farmer

+ acreage hired from others

- acreage hired to others.

	Zone 1	Zone 2	
		1976 short rains	1977 long rains
Mean acreage	7.6	6.4	6.6
Standard deviation	3.9	3.1	3.1

Zone 3		Overall	
1976 short rains	1977 long rains	1976 short rains	1977 long rains
14.8	15.2	9.1	9.3
14.3	14.3	9.2	9.3

Zone 3		Overall	
1976 short rains	1977 long rains	1976 short rains	1977 long rains
17.2	17.6	10.1	10.3
13.4	13.4	9.2	9.2

(b) <u>Division of farms among relatives*</u>

	Zone 1	Zone 2	Zone 3	Overall
Number of divided farms	3	6	12	21
Proportion of farms divided	0.13	0.25	0.57	0.30
Mean number among whom divided	2	2.2	2.8	2.6
Mean size of pieces given to relatives to farm, by the main cultivator (acres)	1.5	1.7	1.9	1.8

*In such cases the farm is divided among wives or sons who each cultivate a piece separately, or sometimes a few acres is given to the mother to cultivate separately.

(c) <u>Acreage for which the interviewee is responsible</u>

= total acreage of all farms owned

\+ acreage hired from others

\- acreage hired to others

\- acreage cultivated by other family members among whom the farm is divided.

These acreages include parts of the farm that are stoney or fallow, except in the cases where the minor cultivator was interviewed. Acreages are as stated by the farmers rather than the official ones.

2. <u>Land bought or inherited</u>

	Zone 1
Inherited land at adjudication	18
Inherited land from father	1
Bought the land	4
Bought part, inherited part	1
	24

3. (a) <u>Number of years lived in Kabare Location</u>

	Zone 1
10-19	3
20-29	0
30-39	3
40-49	5
50-59	6
60-69	6
70-79	1
	24

Zone 2	Zone 3	Total
Number of farmers who		
18	16	52
3	1	5
3	2	9
0	2	3
24	21	69

Zone 2	Zone 3	Total
Number of farmers		
0	0	3
0	2	2
10	3	16
3	6	14
3	3	12
6	3	15
2	3	6
24	20	68

(b) Number of years lived on that farm

Mean

(range)

(c) Number of farmers who have relatives living quite near to their farm

Number of responses

Proportion

4. Farmers who have ever done any other type of work

Skilled

Unskilled

Total

Currently employed

Zone 1	Zone 2	Zone 3	Overall
21.0	21.9	17.1	20.1
(4-55)	(½-75)	(2-28)	(½-75)
19	17	13	49
24	22	21	67
0.79	0.77	0.62	0.73
	Number (proportion)		
8 (0.33)	6 (0.25)	7 (0.33)	21 (0.30)
5 (0.21)	9 (0.38)	9 (0.43	23 (0.33)
13 (0.54)	15 (0.63)	16 (0.76)	44 (0.64)
8 (0.33)	5 (0.21)	3 (0.14)	16 (0.23)

5. <u>Ownership of cattle</u>

(i) <u>Grade cows</u>

Number of farmers owning
Proportion of farmers owning
Mean number of cows owned
(range)

(ii) <u>Local cows</u>

Number of farmers owning
Proportion of farmers owning
Mean number of cows owned
(range)

(iii) <u>Grade calves</u>

Number of farmers owning
Proportion of farmers owning
Mean number of calves owned
(range)

Zone 1	Zone 2	Zone 3	Overall
20	9	7	36
0.83	0.38	0.33	0.52
2.2	1.2	3.9	2.3
(1-4)	(1-2)	(1-10)	(1-10)
3	10	17	30
0.13	0.42	0.81	0.43
1.3	1.7	2.8	2.3
(1-2)	(1-4)	(1-10)	(1-10)
16	6	7	29
0.67	0.25	0.33	0.42
1.6	1.5	2.9	1.9
(1-3)	(1-4)	(1-8)	(1-8)

		Zone 1
(iv)	<u>Local Calves</u>	
	Number of farmers owning	1
	Proportion of farmers owning	0.04
	Mean number of calves owned	1.0
	(range)	-
(v)	<u>Grade steers</u>	
	Number of farmers owning	1
	proportion of farmers owning	0.04
	number of steers owned	1
(vi)	<u>Local oxen</u>	
	Number of farmers owning	2
	Propoertion of farmers owning	0.08
	Mean number of oxen owned	3.5
	(range)	(1-4)

Zone 2	Zone 3	Overall
7	8	16
0.29	0.38	0.23
1.7	3.0	2.3
(1-3)	(1-6)	(1-6)
1	1	3
0.04	0.05	0.04
1	1	1
5	13	20
0.21	0.62	0.29
3.6	3.2	3.3
(1-6)	(1-6)	(1-6)

(6) Other livestock

(i) Adult goats

	Zone 1
Number of farmers owning	11
Proportion of farmers owning	0.46
Mean number of goats owned	2.1
(range)	(1-3)

(ii) Young goats

Number of farmers owning	4
Proportion of farmers owning	0.17
Mean number of goats owned	1.8
(range)	(1-3)

(iii) Adult sheep

Number of farmers owning	16
Proportion of farmers owning	0.67
Mean number of sheep owned	2.4
(range)	(1-5)

Zone 2	Zone 3	Overall
14	16	41
0.58	0.76	0.59
2.0	5.4	3.3
(1-4)	(1-15)	(1-15)
3	10	17
0.13	0.48	0.25
1.0	3.0	2.4
-	(1-6)	(1-6)
10	11	37
0.42	0.52	0.54
2.7	3.0	2.7
(1-6)	(1-7)	(1-7)

		Zone 1
(iv)	Young sheep	
	Number of farmers owning	10
	Proportion of farmers owning	0.42
	Mean number of sheep owned	1.5
	(range)	(1-3)
(v)	Pigs	
	Number of farmers owning	0
	Number of pigs owned	-
(vi)	Donkeys	
	Number of farmers owning	0
	Number of donkeys owned	0

Zone 2	Zone 3	Overall
3	7	20
0.13	0.33	0.29
1.7	1.4	1.5
(1-3)	(1-3)	(1-3)
1	1	2
1	1	1
3	4	7
1	1	1

(vii) Chickens	Zone 1	Zone 2	Zone 3	Overall
Number of farmers owning	22	22	19	63
Proportion of farmers owning	0.92	0.92	0.90	0.91
Mean number of chickens owned	7.6	14.1	11.5	11.1
(range)	(1-25)	(1-70)	(2-30)	(1-70)

Notes:

(a) In cases where the farm was divided, the total numbers of livestock on the farm were taken.

(b) The mean number owned has as divisor the number of farmers owning, rather than the number of farmers in the Zone.

(c) The numbers of chickens are usually rough guesses on the part of the farmer.

7. Acreages of perennial crops

(i) Coffee

	Zone 1	Zone 2	Zone 3		Overall
Number of farmers growing	20	20	3*		43
Proportion of farmers growing	0.83	0.83	0.14		0.62
Mean acreage	0.9	0.7	0.5		0.8
Standard deviation	0.6	0.3	0.5		0.5

*These three farmers each had coffee stems on a relative's farm in Zone 1 or Zone 2.

(ii) Tea

	Zone 1	Zone 2	Zone 3		Overall
Number of farmers growing	16				16
Proportion of farmers growing	0.67				0.67
Mean acreage	2.0				2.0
Standard deviation	1.5				1.5

No tea was grown in zone 2 or Zone 3.

(iii) Pasture grass

	Zone 1	Zone 2	Zone 3		Overall
Number of farmers growing	24	9	5	(12)	38
Proportion of farmers growing	1.00	0.38	0.24	(0.57)	0.55
Mean acreage	1.5	0.4	5.4	(2.9)	1.7
Standard deviation	1.0	0.3	10.4	(6.7)	3.8

Note

In Zone 1 the pasture grass is usually Kikuyu grass

In Zone 2 the pasture grass is usually Napier (Elephant) grass.

Figures in brackets for Zone 3 apply if fallow parts specifically used for grazing are included as well as the planted pasture grass.

(iv) Bananas	Zone 1	Zone 2	Zone 3	Overall
Number of farmers growing	20	22	10	52
Proportion of farmers growing	0.83	0.92	0.48	0.75
Mean acreage	0.3	0.4	0.5	0.4
Standard deviation	0.4	0.4	0.5	0.4

(v) Sugar cane				
Number of farmers growing	5	6	4	15
Proportion of farmers growing	0.21	0.25	0.19	0.22
Mean acreage	0.3	0.6	1.3	0.7
Standard deviation	0.2	0.6	1.4	0.9

(vi) Sweet Potatoes

	Zone 1	Zone 2	Zone 3	Overall
Number of farmers growing	11	13	3	27
Proportion of farmers growing	0.46	0.54	0.14	0.39
Mean acreage	0.3	0.4	0.3	0.3
Standard deviation	0.3	0.4	0.3	0.3

Note Perennial crops which failed are not counted because the space occupied has most probably been planted with something else since.

(vii) Mangoes

Number of farmers growing	4	20	16	40
Proportion of farmers growing	0.17	0.83	0.76	0.58

(viii) Oranges

Number of farmers growing	3	11	5	19
Proportion of farmers growing	0.13	0.46	0.24	0.28

(ix) Lemons

Number of farmers growing	1	3	4	8
Proportion of farmers growing	0.04	0.13	0.19	0.38

(x) Passion fruit

Number of farmers growing

Proportion of farmers growing

(xi) Macadamia

Number of farmers growing

Proportion of farmers growing

(xii) Avocado

Number of farmers growing

Proportion of farmers growing

(xiii) Pawpaw

Number of farmers growing

Proportion of farmers growing

(xiv) Guavas

Number of farmers growing

Proportion of farmers growing

Zone 1	Zone 2	Zone 3	Overall
17	10	3	30
0.71	0.42	0.14	0.43
6	8	1	15
0.25	0.33	0.05	0.22
2	10	0	12
0.08	0.42	0	0.17
1	3	4	8
0.04	0.13	0.19	0.12
3	2	0	5
0.13	0.08	0	0.07

		Zone 1
(xv)	Tree Tomato	
	Number of farmers growing	11
	Proportion of farmers growing	0.46
(xvi)	Sisal (grown round the boundary only)	
	Number of farmers growing	0
	Proportion of farmers growing	0
(xvii)	Arrowroot	
	Number of farmers growing	10
	Proportion of farmers growing	0.42
(xviii)	Yams	
	Number of farmers growing	8
	Proportion of farmers growing	0.33

Zone 2	Zone 3	Overall
0	0	11
0	0	0.16
7	21	28
0.29	1.00	0.41
5	6	21
0.21	0.29	0.30
9	2	19
0.38	0.10	0.28

9. <u>Short Rains Planting 1976</u>

(i) <u>Maize (pure stand)</u>

Number of farmers growing

Proportion of farmers growing

Mean acreage

Standard deviation

(ii) <u>Beans (pure stand)</u>

Number of farmers growing

Proportion of farmers growing

Mean acreage

Standard deviation

(iii) <u>Maize/Bean Mixture</u>

Number of farmers growing

Proportion of farmers growing

Mean acreage

Standard deviation

Zone 1	Zone 2	Zone 3	Overall
8	12	14	34
0.33	0.5	0.67	0.51
1.5	1.3	2.9	2.0
1.4	1.2	2.0	1.8
10	10	5	25
0.42	0.42	0.24	0.37
1.6	1.1	3.1	1.7
0.9	1.2	2.8	1.6
16	13	11	40
0.67	0.54	0.52	0.60
1.4	1.7	5.9	2.8
1.1	1.0	4.5	3.1

(iv) <u>Potatoes</u>

	Zone 1
Number of farmers growing	10
Proportion of farmers growing	0.42
Mean acreage	0.5
Standard deviation	0.4

(v) <u>Cabbages</u>

Number of farmers growing	2
Proportion of farmers growing	0.08
Mean acreage	0.2

(vi) <u>Tomatoes</u>

Number of farmers growing	8
Proportion of farmers growing	0.33
Mean acreage	0.3
Standard deviation	0.3

(vii) <u>Cowpeas</u>

Number of farmers growing	9
Proportion of farmers growing	0.38
Mean acreage	0.1
Standard deviation	0.2

Zone 2	Zone 3	Overall
18	13	41
0.75	0.62	0.61
0.3	0.3	0.3
0.3	0.2	0.3
3	1	6
0.13	0.05	0.09
0.1	1.0	0.3
7	3	18
0.29	0.14	0.26
0.1	0.3	0.2
0.1	0.3	0.3
15	8	32
0.63	0.38	0.46
0.1	0.2	0.1
0.1	0.3	0.2

(viii) <u>Sunflower</u>

Number of farmers growing

Proportion of farmers growing

Mean acreage

Standard deviation

(ix) <u>Cotton</u>

Number of farmers growing

Proportion of farmers growing

Mean acreage

Standard deviation

(x) <u>Maize/Cowpea mixture</u>

Number of farmers growing

Proportion of farmers growing

Mean acreage

Standard deviation

Zone 1	Zone 2	Zone 3	Overall
0	0	9	9
0	0	0.43	0.13
0	0	1.8	1.8
0	0	2.0	2.0
0	0	3	3
0	0	0.13	0.04
0	0	1.3	1.3
0	0	0.6	0.6
0	1	7	8
0	0.04	0.29	0.12
-	0.5	0.14	0.2
-	-	0.2	0.2

Maize/Beans/Cow peas mixture

Number of farmers growing

Proportion of farmers growing

Sorghum

Number of farmers growing

Proportion of farmers growing

Cassava

Number of farmers growing

Proportion of farmers growing

Carrots

Number of farmers growing

Proportion of farmers growing

Onions

Number of farmers growing

Proportion of farmers growing

Zone 1	Zone 2	Zone 3	Overall
0	1	1	2
0	0.04	0.05	0.03
0	6	2	8
0	0.25	0.10	0.12
3	14	7	24
0.13	0.58	0.33	0.35
1	0	1	2
0.04	0	0.05	0.03
1	2	0	3
0.04	0.08	0	0.04

Tobacco

Number of farmers growing

Proportion of farmers growing

Mean Acreage

Maize/Tobacco mixture

Number of farmers growing

Proportion of farmers growing

Acreage

Mboyo (black grams)

Number of farmers growing

Proportion of farmers growing

Mean acreage

China (yellow grams)

Number of farmers growing

Proportion of farmers growing

Mean acreage

Zone 1	Zone 2	Zone 3	Overall
3	0	0	3
0.13	0	0	0.04
0.4	0	0	0.4
1			
0.04			
1			
-	-	2	-
-	-	0.10	-
-	-	1	-
-	-	3	-
-	-	0.14	-
-	-	1.2	-

Ndengu (green grams)

	Zone 1
Number of farmers growing	-
Acreage	-

Maize/Mboyo mixture

Number of farmers growing	-
Acreage	-

Maize/China mixture

Number of farmers growing	-
Acreage	-

Pumpkins

Number of farmers growing	1

Other crops

Millet	Zone 2	1 farmer
Sukuma wiki	Zone 1	1 farmer
Spinach	Zone 2	1 farmer
Peppers	Zone 1	1 farmer

Zone 2	Zone 3	Overall
-	1	-
-	1	-
-	1	-
-	3.5	-
-	1	-
-	0.5	-
0	1	

10. Long Rains Planting 1977

(i) Maize

	Zone 1	Zone 2	Zone 3	Overall
Number of farmers growing	10	14	13	37
Proportion of farmers growing	0.42	0.58	0.62	0.54
Mean acreage	1.9	1.5	5.9	3.2
Standard deviation	1.4	0.8	6.1	4.2

(ii) Beans

	Zone 1	Zone 2	Zone 3	Overall
Number of farmers growing	6	13	7	26
Proportion of farmers growing	0.25	0.54	0.33	0.38
Mean acreage	0.9	1.1	2.5	1.4
Standard deviation	0.8	0.7	2.0	1.3

(iii) Maize/Bean mixture

	Zone 1	Zone 2	Zone 3	Overall
Number of farmers growing	4	17	15	36
Proportion of farmers growing	0.17	0.71	0.71	0.52
Mean acreage	1.8	2.4	5.4	3.6
Standard deviation	1.5	1.4	2.9	2.7

(iv) <u>Potatoes</u>

Number of farmers growing
Proportion of farmers growing
Mean acreage
Standard deviation

(v) <u>Cabbages</u>

Number of farmers growing
Proportion of farmers growing
Mean acreage

(vi) <u>Tomatoes</u>

Number of farmers growing
Proportion of farmers growing
Mean acreage
Standard deviation

Zone 1	Zone 2	Zone 3	Overall
22	20	16	58
0.92	0.83	0.76	0.84
0.6	0.4	0.4	0.5
0.4	0.4	0.3	0.4
16	3	1	20
0.67	0.13	0.05	0.29
0.4	0.2	1.0	0.4
5	8	5	18
0.21	0.33	0.24	0.26
0.3	0.1	0.4	0.2
0.2	0.2	0.2	0.2

(vii) <u>Cowpeas</u>

	Zone 1
Number of farmers growing	5
Proportion of farmers growing	0.21
Mean acreage	0.1
Standard deviation	0.1

(viii) <u>Cassava (adding)</u>

Number of farmers growing	5
Proportion of farmers growing	0.21
Mean acreage	0.1
Standard deviation	0.2

(ix) <u>Sunflower</u>

Number of farmers growing	0
Proportion of farmers growing	0
Mean acreage	-
Standard deviation	-

Zone 2	Zone 3	Overall
16	9	30
0.67	0.43	0.43
0.1	0.2	0.1
0.2	0.2	0.2
14	11	30
0.58	0.52	0.43
0.1	0.2	0.1
0.1	0.2	0.2
0	7	7
0	0.33	0.10
-	1.5	1.5
-	1.2	1.2

(x) Cotton	Zone
Number of farmers growing	0
Proportion of farmers growing	0
Mean acreage	-

(xi) Maize/Cow peas mixture	
Number of farmers growing	0
Proportion of farmers growing	0
Mean acreage	-
Standard deviation	-

(xii) Maize/Beans/Cowpeas mixture	
Number of farmers growing	0
Proportion of farmers growing	-
Mean acreage	-

Sorghum	
Number of farmers growing	0
Proportion of farmers growing	0

1	Zone 2	Zone 3	Overall
	0	2	2
	0	0.10	0.03
	-	1.0	1.0
	3	6	9
	0.13	0.25	0.13
	0.6	0.2	0.3
	0.4	0.2	0.3
	2	4	6
	0.08	0.19	0.09
	0.4	-	-
	14	13	27
	0.58	0.62	0.39

Carrots	Zone 1
Number of farmers growing	1
Proportion of farmers growing	0.04

Maize/Tobacco Mixture

Number of farmers growing	1
Acreage	0.5

Maize/Sunflower mixture

Number of farmers growing	-
Acreage	-

Maize/ Coriander mixture

Number of farmers growing	-
Acreage	-

Mboyo (black grams)

Number of farmers growing	-
Mean acreage	-

Zone 2	Zone 3	Overall
1	1	3
0.05	0.05	0.04
-	-	-
-	-	-
-	1	-
-	1	-
-	1	-
-	1	-
-	2	-
-	1	-

China (yellow grams)

Number of farmers growing

Mean acreage

Maize/Mboyo Mixture

Number of farmers growing

Mean acreage

Maize/China Mixture

Number of farmers growing

Acreage

Ndengu (green grams)

Number of farmers growing

Acreage

Wheat

Number of farmers

Acreage

Zone 1	Zone 2	Zone 3	Overall
-	-	3	-
-	-	1.3	-
-	-	3	-
-	-	2.2	-
-	-	1	-
-	-	7	-
-	-	1	-
-	-	1	-
-	-	1	-
-	-	0.75	-

Other Crops

Onion	Zone 2	2 farmers
Pumpkins	Zone 1	1 farmer
Millet	Zone 2	1 farmer

Notes on acreages of seasonal crops planted in short rains 1976 and long rains 1977

(a) Seasonal crops which failed are counted, because it is the decision to plant and the allocation of the farm to different crops, which is the matter of interest.

(b) Where one crop is planted with another, e.g. sweet potatoes are planted with maize, then half the acreage is allotted to pure stand of each, unless the mixture (e.g. maize and beans) is a frequently occuring one, when it is classified separately.

(c) Acreages less than 0.1 are neglected. 'A small patch' is treated as 0 acres although the farmer is counted as one growing the crop. Since larger fractions such as ¼ or ½ acre are likely to be over-stated by the farmer, it is considered justfiable to neglect small fractions of an acre.

(d) The mean acreage always has as divisor the number of farmers growing the crop rather than the number of farmers in the Zone.

Mean proportion of farm fallow	Zone 1	Zone 2	Zone 3	Overall
Number of farms on which the calculation is based	23	23	21	67
Mean proportion fallow - short rains 1976	0.16	0.37	0.46	0.32
Mean proportion fallow - long rains 1977	0.18	0.20	0.27	0.21
Farmers who stated crop acreages which added to more than their estimation of the acreage of their farm. Short rains 1976				
Number of farmers who overstated	8	5	3	16
Proportion of farmers	0.33	0.22	0.14	0.24
Mean proportion by which total farm acreage was overstated by these farmers	0.19	0.38	0.09	0.23
Long rains 1977				
Number of farmers who overstated	6	9	3	18
Proportion of farmers	0.25	0.39	0.14	0.27
Mean proportion by which total farm acreage was overstated by those farmers.	0.20	0.23	0.13	0.20

12. Reasons for mixing crops rather than growing separately	Zone 1	Zone 2	Zone 3	Overall
	Number of times mentioned			
a. Shortage of land	7	4	5	16
b. Shortage of labour-easier to weed	2	2	2	6
c. If one fails the other might do well	8	7	7	22
d. Have always mixed and never grown separately	1	5	6	12
e. To experiment	2	1	0	3
f. One crop shades the other	1	0	0	1
g. Gives good yields	0	0	1	1

13. Reasons for growing sorghum				
a. For porridge	0	13	12	25
b. To sell	0	1	0	1
c. For food and sometimes for beer	0	2	0	2

14. <u>Reasons for growing cassava</u>

(a) Food for cattle

(b) Food for people

(c) To sell

(d) Resists drought so that, even if other crops fail, famine is averted

(e) To experiment

15.a(i) <u>The 'most profitable' crop or enterprise</u>

Coffee

Tea

Maize

Beans

Cattle

Tomatoes

Pawpaw

Bananas

Zone 1	Zone 2	Zone 3	Overall
1	4	7	12
6	10	10	26
3	6	1	10
0	5	2	7
2	0	0	2

Number of farmers

14	17	2	33
9	0	0	9
0	2	12	14
0	2	4	6
1	0	2	3
0	1	0	1
0	1	0	1
0	1	0	1
24	24	20	68

(ii) <u>The second most profitable crop or enterprise</u>

Coffee
Tea
Beans
Maize
Bananas
Dairying
Tomatoes
Cassava
Cabbages
Mboyo (black grams)
China (yellow grams)

(iii) <u>The third most profitable crop or enterprise</u>

Dairying
Maize
Beans
Potatoes
Tomatoes

Zone 1	Zone 2	Zone 3	Total
5	1	0	6
7	0	0	7
2	9	11	22
2	7	6	15
0	2	0	2
6	1	0	7
0	1	0	1
0	2	0	2
1	1	0	2
0	0	2	2
0	0	1	1
23	24	20	67

5	1	0	6
4	8	1	13
4	4	1	9
2	2		4
3	1	1	5

(iii) The third most profitable crop or enterprise (CONTD....)

crop or enterprise	Zone 1	Zone 2	Zone 3	Total
Sugar cane	0	1	0	1
Sweet potatoes	0	1	0	1
Bananas	0	0	2	2
Sunflower	0	0	2	2
Cotton	0	0	1	1
Cassava	0	0	1	1
Sorghum	0	0	1	1

Scoring for profitability

5 = most profitable 4 = 2nd most profitable 3 = 3rd most profitable
2 = 4th most profitable 1 = 5th most profitable.

(iv) Total Score for profitability by crop or enterprise

by crop or enterprise	Zone 1	Zone 2	Zone 3	Total
Coffee	90	89	10	189
Tea	73	0	0	73
Maize	9	64	89	162
Beans	33	60	67	160
Dairying	47	7	10	64
Potatoes	12	8	0	20

Total score for profitability (contd....)	Zone 1	Zone 2	Zone 3	Total
Bananas	0	15	6	21
Tomatoes	9	12	5	26
Sunflower	0	0	6	6
Mboyo	0	0	10	10
China	0	0	4	4
Cotton	0	0	5	5
Sugar cane	0	3	0	3
Sweet potatoes	0	3	2	5
Cassava	0	8	3	11
Sorghum	0	0	3	3
Cabbages	6	4	1	11
Pawpaw	0	5	0	5

(v) Order of profitability of crops by zone

Zone 1	Zone 2	Zone 3	Overall
1. Coffee	1. Coffee	1. Maize	1. Coffee
2. Tea	2. Maize	2. Beans	2. Maize
3. Dairying	3. Beans	3. (Coffee	3. Beans
4. Beans	4. Bananas	(Dairying	4. Tea
5. Potatoes	5. Tomatoes	(Mboyo	5. Dairying

Order of profitability of crops

Zone 1

6. Maize
   Tomatoes

8. Cabbages

by zone (contd...)

Zone 2	Zone 3	Overall
6. (Potatoes	6. (Bananas	6. Tomatoes
(Cassava	(Sunflower	7. Bananas
8. Dairying	8. (Tomatoes	8. Potatoes
9. Pawpaw	(Cotton	9. (Cassava
10. Cabbages	10. China	(Cabbages
11. (Sugar-Cane	11. (Cassava	11. Mboyo
(Sweet potatoes	(Sorghum	12. Sunflower
	13. Sweet potatoes	13. (Cotton
	14. Cabbages	(Sweet potatoes
		(Pawpaw
		16. China
		17. (Sorghum
		(Sugar cane

15 (b) <u>Reasons for not growing more of most profitable crops</u>

(a) Lack of manure/fertilizer/spray

(b) Shortage of land

(c) Shortage of labour

(d) Lack of money

(e) Climate not very suitable)
Already have sufficient)

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16 (a) <u>Crops or enterprises adopted recently (in the last few years)</u>

Dairying
Hybrid maize
Potatoes
Wheat
Bananas
Tomatoes
Sunflower
Mboyo
China

Zone 1	Zone 2	Zone 3	Total
Number of times mentioned			
3	1	0	4
12	11	12	35
12	11	7	30
2	7	4	13
3	7	10	20

2	0	0	2
0	1	1	2
1	1	0	2
0	0	1	1
1	0	0	1
3	1	1	5
0	0	7	7
0	0	2	2
0	0	1	1

Crops/enterprises recently adopted

Sugar cane

Cassava

Sorghum

Cabbages

Tobacco

Trees (for building)

Carrots

Onions

Yams

Passion fruit

Pawpaw

Macadamia

16 (b) Reasons for adopting the new crop/crops

(a) Good price

(b) Climate suitable

(c) Introduced by Agricultural Extension Staff

(contd..)

Zone 1	Zone 2	Zone 3	Total
0	0	1	1
1	0	0	1
0	0	1	1
0	0	1	1
1	0	0	1
0	1	0	1
0	0	1	1
0	1	0	1
1	0	0	1
2	0	0	2
0	1	0	1
0	1	0	1

Number of times mentioned

5	4	6	15
1	1	2	4
1	0	5	6

Reasons for adopting the new crop/crops (Contd...)

(d) Good for food

(e) To experiment

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17. Crops/enterprises recently given up (in the last few years)

Sorghum and millet

Millet

Sorghum

Coffee

Local maize

Bananas

Mboyo

Cotton

Sugar-cane

Sweet potatoes

Cassava

Cabbages

Tobacco

Peppers

Zone 1	Zone 2	Zone 3	Total
Number of times mentioned			
4	1	4	9
6	6	6	18

Zone 1	Zone 2	Zone 3	Total
Number of farmers			
8	1	0	9
2	1	1	4
0	1	0	1
2	0	0	2
0	1	0	1
0	0	2	2
0	0	1	1
0	0	2	2
1	1	0	2
1	0	0	1
1	0	0	1
0	1	0	1
0	1	0	1
0	1	0	1

17. (b) Reasons for ceasing to grow these crops

Reasons for ceasing to grow these crops	Zone 1	Zone 2	Zone 3	Overall
	Number of times mentioned			
(a) Unfavourable price	1	2	1	4
(b) Climate unsuitable	5	1	3	9
(c) Destroyed by pests/diseases	9	3	0	12
(d) Too much labour was needed	4	2	2	8
(e) Shortage of land	0	1	0	1

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18. (a) Crops in store at the time of interview, stored by the person interviewed. (These may only have represented part of the farm if it was a divided one).

(i) Potatoes (bags)	Zone 1	Zone 2	Zone 3	Overall
Number of farmers storing	12	15	7	34
Proportion of farmers storing	0.50	0.63	0.33	0.49
Mean amount stored	2.6	2.1	2.4	2.3
Standard deviation	2.7	1.8	2.6	2.2
(ii) Maize (bags)				
Number of farmers storing	20	22	15	57
Proportion of farmers storing	0.83	0.92	0.71	0.83
Mean amount stored	5.0	5.3	5.8	5.3
Standard deviation	4.8	5.8	3.7	4.9

(iii) Beans (bags)

Number of farmers storing

Proportion of farmers storing

Mean amount stored

Standard deviation

(iv) Sorghum (bags)

Number of farmers storing

Proportion of farmers storing

Mean amount stored

Standard deviation

18. (b)

(a) Much of stored crop lost because of pests

(b) Therefore chemical used for prevention

Zone 1	Zone 2	Zone 3	Overall
22	18	13	53
0.92	0.75	0.62	0.77
2.5	1.4	2.1	2.1
2.0	1.0	2.1	1.8
0	5	7	12
0	0.21	0.33	0.17
-	0.3	0.2	0.3
-	0.2	0.2	0.2

Number of farmers			
Zone 1	Zone 2	Zone 3	Overall
21	22	20	63
23	24	18	65

18. (b) (Contd...)

	Zone 1
(c) Difficulty in storing if have large amounts	10
(d) Would store greater amounts if did not have these difficulties.	21
Depends on harvest	1

19. (a) Food bought in 1976

(i) Maize (bags)

	Zone 1
Number of farmers buying	9
Proportion of farmers buying	0.38
Mean amount bought	2.9
Standard deviation	1.7

(ii) Beans (Bags) (including for eating and

Number of farmers buying	7
Proportion of farmers buying	0.29
Mean amount bought	0.9
Standard deviation	0.4

Number of farmers

Zone 2	Zone 3	Overall
14	4	28
19	18	58
4	0	5

	Zone 2	Zone 3	Overall
	11	8	28
	0.46	0.38	0.41
	3.6	3.4	3.3
	3.1	3.0	2.6
for planting)			
	11	10	28
	0.46	0.48	0.41
	1.4	1.0	1.1
	1.2	0.8	0.9

(iii) <u>Potatoes (bags)</u> (including for

Number of farmers buying
Proportion of farmers buying
Mean amount bought
Standard deviation

(iv) <u>Cabbages</u> (bags)

Number of farmers buying
Proportion of farmers buying
Mean amount bought
Standard deviation

(v) <u>Tomatoes (kg)</u> (Assuming 1 bag

Number of farmers buying
Proportion of farmers buying
Mean amount bought
Standard deviation

eating and for planting]

Zone 1	Zone 2	Zone 3	Overall
8	12	7	27
0.33	0.50	0.33	0.39
3.5	2.1	1.9	2.5
1.7	2.7	3.6	2.7
9	20	17	46
0.38	0.83	0.81	0.67
2.7	2.6	0.8	1.9
3.5	2.7	1.3	2.6

= 70kg,1kg sells for sh.1]

12	15	17	44
0.50	0.63	0.81	0.64
66.3	50.6	19.2	60.0
43.2	57.3	31.5	129.4

(vi) Fruits	Zone 1	Zone 2	Zone 3	Overall
Number of farmers buying	5	6	10	21

(vii) Milk (bottles per year where 1 bottle ≃ 750 ml.)

Number of farmers buying	4	10	9	23
Proportion of farmers buying	0.17	0.42	0.42	0.33
Mean amount bought	121.3	282.9	186.1	216.9
Standard deviation	164.9	360.5	154.0	263.7

(b) Reasons why more of these foods were not produced on own farm rather than buying

	Number of times mentioned			
Shortage of land	6	4	1	11
Shortage of labour	4	5	1	10
Climate or soil unsuitable, pests destroyed etc.	7	14	16	37
Could not afford to hire necessary labour	0	3	1	4
Shortage of money	0	2	0	2
Sickness	0	1	0	1

20. Crops Sold in 1976

(i) Coffee (kg)

Number of farmers selling

Proportion of farmers selling

Mean amount sold

Standard deviation

(ii) Tea (kg)

Number of farmers selling

Proportion of farmers selling

Mean amount sold

Standard deviation

(iii) Maize (bags)

Number of farmers selling

Proportion of farmers selling

Mean amount sold

Standard deviation

Zone 1	Zone 2	Zone 3	Overall
17	20	3	40
0.71	0.83	0.14	0.58
2482	1723	2483	2102
2462	1455	3912	2110
16	0	0	16
0.67	0	0	0.23
3270-	-	-	3270
3149-	-	-	3149
10	14	18	42
0.42	0.58	0.86	0.61
4.2	6.0	22.4	12.6
3.6	4.3	29.5	21.0

(iv) Beans (bags)

Number of farmers selling

Proportion of farmers selling

Mean amount sold

Standard deviation

(v) Potatoes (bags)

Number of farmers selling

Proportion of farmers selling

Mean amount sold

Standard deviation

(vi) Milk (bottles/year where 1 bottle

Number of farmers selling

Proportion of farmers selling

Mean amount sold

Standard deviation

(vii) Bananas (whole bunches)

Number of farmers selling

Proportion of farmers selling

Mean amount sold

Standard deviation

Zone 1	Zone 2	Zone 3	Overall
9	9	11	29
0.38	0.38	0.52	0.42
3.8	1.6	5.6	3.8
3.8	1.3	5.6	4.3
7	4	3	14
0.29	0.17	0.14	0.20
4.6	3.8	2.0	3.8
3.9	3.5	1.7	3.4
≈ 750 ml)			
11	3	5	19
0.46	0.13	0.24	0.28
1794	1733	3035	2111
1751	1807	2668	1993
4	10	3	17
0.17	0.42	0.14	0.25
17.6	77.0	3.3	50.0
25.2	184.6	5.8	142.9

(viii) Tomatoes (kg) (Assuming 1 bag =
Horticultural Co-

Number of farmers selling

Proportion of farmers selling

Mean amount sold

Standard deviation

(ix) Cabbages (bags)

Number of farmers selling

Proportion of farmers selling

Mean amount sold

Standard deviation

(x) Mangoes (bags)

Number of farmers selling

Proportion of farmers selling

Mean amount sold

Standard deviation

70kg, 1 kg sells for 80 cts at
-operative, 1/= in local market)

Zone 1	Zone 2	Zone 3	Overall
5	2	2	9
0.21	0.08	0.10	0.13
512	470	1675′	426.1
569.2	466.7	60.1	459.9
8	1	1	10
0.33	0.04	0.05	0.14
18.6	4	30	18.3
17.5	-	-	16.6
1	5	6	12
0.04	0.21	0.29	0.17
2	7.4	4.5	5.5
-	5.7	7.7	6.5

	Number of farmers selling *Mean and (range) for amount sold*			
Other crops sold in 1976	Zone 1	Zone 2	Zone 3	Overall
Mboyo (black grams)	0	0	2	-
(bags)	-	-	22(0-3-4)	-
China (yellow grams)	0	0	1	-
(bags)	-	-	15	-
Cotton	0	0	2	-
(bags)	-	-	10.5(3-18)	-
Sugar cane	0	3	2	-
(shs)	-	633(100-100)	180(60-300)	-
Cassava	0	4	1	-
(shs)	-	60(1-120)	60	-
Oranges	0	2	1	-
(bags)	-	5.5(3-8)	2	-
Lemons	0	1	2	-
(bags)	-	1	1.5(1-2)	-
Tobacco	1	0	0	-
(kg)	16	-	-	-

Other crops sold in 1976 (Contd....)	Zone 1	Zone 2	Zone 3	Overall
Macadamia	0	1	0	-
(kg)	-	8	-	-
Cowpea leaves	-	1	-	-
(shs)	-	250	-	-
Onion	-	1	-	-
(shs)	-	80	-	-
Avocado	-	1	-	-
(bags)	-	2	-	-

21. Crops kept in 1976 for food for the family or to feed the animals

(i) Maize (bags)

	Zone 1	Zone 2	Zone 3	Overall
Number of farmers storing	23	24	20	67
Proportion of farmers storing	0.96	1.00	0.83	0.97
Mean amount stored	6.8	7.0	7.5	7.1
Standard deviation	6.3	5,3	8.4	6.6

(ii) Beans (bags)

	Zone 1	Zone 2	Zone 3	Overall
Number of farmers storing	24	21	18	63
Proportion of farmers storing	1.00	0.88	0.86	0.91

Beans (bags) (Contd...)	Zone 1	Zone 2	Zone 3	Overall
Mean amount stored	2.1	1.9	2.5	2.1
Standard deviation	1.5	1.9	1.6	1.7
(iii) Potatoes (bags)				
Number of farmers storing	21	19	12	52
Proportion of farmers storing	0.88	0.79	0.57	0.75
Mean amount stored	7.7	2.6	3.0	4.8
Standard deviation	7.2	2.0	2.3	5.4
(iv) Sorghum (bags)				
Number of farmers storing	0	6	8	14
Proportion of farmers storing	0	0.25	0.38	0.20
Mean amount stored	-	0.8	0.5	0.6
Standard deviation	-	0.7	0.4	0.5
(v) Milk (bottles/year used for feeding the family and for calves where 1 bottle ≈ 750 ml.)				
Number of farmers keeping	18	10	13	41
Proportion of farmers keeping	0.75	0.42	0.62	0.59
Mean amount kept	2842	1697	1673	2192
Standard deviation	2052	1605	1291	1791

Other crops stored: Green grams, and cowpea seeds, by 1 farmer in Zone 3.

23. <u>Crops given in 1976 (to relatives etc.</u>

(i) <u>Maize(bags)</u>

Number of farmers giving
Proportion of farmers giving
Mean amount given
Standard deviation

(ii) <u>Beans (bags)</u>

Number of farmers giving
Proportion of farmers giving
Mean amount given
Standard deviation

(iii) <u>Potatoes (bags)</u>

Number of farmers giving
Proportion of farmers giving
Mean amount given
Standard deviation

.)

Zone 1	Zone 2	Zone 3	Overall
13	18	11	42
0.54	0.75	0.52	0.61
1.9	1.5	1.3	1.6
1.4	1.3	1.4	1.4
11	10	10	31
0.46	0.42	0.48	0.45
0.5	0.5	0.5	0.5
0.3	0.4	0.4	0.4
8	8	5	21
0.33	0.33	0.24	0.30
1.7	0.8	0.6	1.1
2.2	0.6	0.4	1.5

Other foods given in 1976	Zone 1	Zone 2	Zone 3	Overall
	Number of farmers			
	Mean (range) for amounts given			
Milk (bottles/year)	5	1	1	7
(1 bottle = 750ml.)	159(6-730)	371	1095	-
Cabbages	3	0	0	3
(bags)	1.3(1-3)	-	-	-
Bananas	1	6	4	11
(whole bunches)	4	17.3(4-30)	1.3	-
Mangoes	0	4	4	8
(bags)	-	1.4(0.5-3)	3.8(0.3-10)	-
Tomatoes	1	1	0	2
(kgs)	24	5	-	-
Pumpkins	1	0	0	1
(bags)	2	-	-	-
Cowpea leaves	1	0	0	-
Sorghum	0	1	1	-
(debes)		1	1	-

	Zone 1	Zone 2	Zone 3	Overall
	Number of farmers			
	Mean (range) for amounts given			
Oranges	0	1	0	-
(bags)	-	0.5	-	-
Sweet potatoes	1	0	0	-
(debes)	2	-	-	-
Fruits unspecified	0	1	0	-
(bags)	-	1	-	-

24. Exchanging of food crops with friends (barter)

	Zone 1	Zone 2	Zone 3	Overall
	Number of exchanges			
Maize and Potatoes	2	4	0	6
Cabbages for tomatoes	1	0	0	1
Beans for beans	2	2	0	4
Potatoes for salt	1	0	0	1
Beans for salt	2	1	0	3
Beans for sorghum	0	1	0	1

Exchange of food crops (Contd...)

Maize hybrid 512 for hybrid 613

Maize for salt

Katumani Maize and local maize

Total no. of exchanges

(The quantities exchanged were of the

2 bags)

25. Type of maize grown

Hybrid only

Hybrid and also local

Hybrid and also Katumani

Katumani and local

Hybrid, Katumani and local

Local maize only

Zone 1	Zone 2	Zone 3	Overall
Number of exchanges			
0	1	0	1
0	0	1	1
0	0	2	2
8	9	3	20
Number of farmers who exchanged (proportion)			
5(0.21)	8(0.33)	2(0.1)	15(0.22)

order of 1 debe or occasionally 1 or

Zone 1	Zone 2	Zone 3	Overall
	Number of Farmers		
17	13	3	33
6	7	1	14
0	2	3	5
0	0	2	2
0	2	11	13
1	0	1	2
24	24	21	69

Type of hybrid maize grown

613 only

512 only

613 and 512

512 and 511

613 and 614

512, 632 and 613

512, 613 and 611

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26 (a) Members of Co-operative Societies etc.

Kabare Coffee Co-operative Society

Gichugu Dairy Co-operative Society

Kirinyaga Horticultural Growers Co-operative Society(proposed)

Kirinyaga Cotton Growers Co-operative Society

KTDA

Ngariama ranching scheme

Baragwi or Inoi Coffee Co-operative Soc

Zone 1	Zone 2	Zone 3	Overall
22	7	0	29
0	2	10	12
0	8	0	8
0	1	6	7
1	0	0	1
0	1	0	1
0	1	0	1
23	20	16	59

Zone 1	Zone 2	Zone 3	Overall
	Number of farmers		
20	20	2	42
10	0	2	12
0	0	3	3
0	0	3	3
16	0	0	16
0	0	1	1
1	0	1	2

26.(b) Advantages gained through being a member of these societies

	Zone 1	Zone 2	Zone 3	Overall
	Number of times mentioned			
Help farmers to sell	13	9	7	29
Give good payments	18	10	3	31
Give loans of money	8	7	2	17
Give loans of inputs, and food	6	7	0	13
Help to pay school fees	3	4	0	7
Distribute inputs to the farmers	7	4	0	11
Keep money for farmers	1	0	1	2

	Use of Chemical fertilizers, manure sprays, insecticides	Zone 1	Zone 2	Zone 3	Overall
		Number of farmers who used			
27 (a)	Chemical fertilizers	23	18	7	48
28 (a)	Manure	21	20	16	57
29 (a)	Fungicides	19	21	5	45
	Insecticides	16	18	8	42

Source of manure	Zone 1
From own animals	12
Bought	1
Some own, some bought	8
	21

27 (b) Crops on which fertilizer used

Tea	16
Coffee	19
Maize	22
Beans	2
Potatoes	10
Cabbages	8
Tomatoes	7
Pasture grass	2

28.(b) Crops on which Manure used

Tea	7
Coffee	17
Maize	21
Beans	0

Zone 2	Zone 3	Total
15	15	42
2	0	3
3	1	12
20	16	57
0	0	16
15	1	35
16	7	45
1	1	4
4	7	21
0	0	8
0	1	8
0	0	2
0	0	7
15	1	33
12	15	48
1	10	11

Crops on which manure used (contd.)	NUMBER OF FARMERS Zone 1	Zone 2	Zone 3	Total
Potatoes	16	9	13	38
Cabbages	7	0	1	8
Tomatoes	5	1	2	8
Bananas	0	3	1	4
Cotton	0	0	3	3
China (yellow grams)	0	0	2	2
Mboyo (black grams)	0	0	3	3
Pasture grass	1	0	1	2
Sunflower	0	0	8	8
29.(b) Crops on which fungicide used				
Coffee	19	19	2	40
Potatoes	15	7	5	27
Tomatoes	9	4	2	15
Cotton	0	0	2	2
China (yellow grams)	0	0	1	1
Crops on which insecticide used				
Maize	17	17	9	43
Cabbages	4	3	1	8
Beans	0	0	4	4

29 (c) No of times coffee sprayed per year	Zone 1	Zone 2	Zone 3	Total
Mean	4.8	3.0	2	3.8
Range	(2-8)	(1-8)	(1-3)	(1-8)

Written records kept	Number of farmers			Total
Including those who used to, or mean to start a	1	3	1	5
at present	1	1	0	2

30. Methods of land preparation	No. of farmers			
(a) Oxen hired for ploughing only	9	13	2	24
Oxen hired for ploughing and planting	0	2	7	9
No days to hire oxen per year				
				Overall
Mean	5.1	4.9	10.4	6.4
(Range)	(2-7)	(1½-12)	(3-20)	(1½-20)

30. (b) Farmers who have ever hired a tractor for land preparation	1	3	8	12

	Number of farmers			
31. (a) Farmers who might change their plans of what crops, how much of each to plant if the rains seemed to be coming late	Zone 1	Zone 2	Zone 3	Total
	20	11	4	35
Farmers who would not change their plans	4	12	17	33

(b) The way in which the plans would be changed -	Number of times mentioned			
- Only wait for rain plant later	14	5	0	19
- Change proportions, planting more of crops which need less rain	2	6	4	12
- Plant varieties which need less rain	0	1	0	1
- Plant a smaller acreage	3	1	0	4
- Delay planting till next season	2	0	1	3

(c) <u>The reason why the plans could not be changed</u>

- Already have seed or plants, so have no alternative crops to plant
- Have already planted (before rain)
- Need all the crops
- Can't predict rainfall or how well the crops will do
- Harvesting and therefore next season's planting would be too much delayed.
- A low part of the farm holds water even if there is little rain

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33 <u>Time of Planting</u>

(a)
- All crops before rains
- All crops after first rain
- Some crops before, some crops after
- Part of farm before, part after

Zone 1	Zone 2	Zone 3	Total
Number of times mentioned			
3	3	7	13
2	6	1	9
1	0	1	2
0	5	7	12
1	0	0	1
0	1	0	1
7	4	0	11
11	6	17	34
6	12	4	22
1	2	1	4

(33) (b) Time of preparing the ground	Zone 1	Zone 2	Zone 3	Total
	Number of farmers			
- All before the rains	24	22	12	58
- Part before, part after first rain	0	1	0	1
- All after the first rain	0	0	9	9

(c) Method of land preparation				
- All by hand(using jembe and panga)	12	4	1	17
- All by ox-plough	8	9	15	32
- Part by hand, part by ox-plough	4	10	1	15
- All by tractor and plough	0	0	1	1
- Part by ox-plough, part by tractor	0	1	3	4

(d) Order of planting crops Ranking 1:1st 2:2nd 3:3rd etc.	Zone 1 Mean rank (Range)	Zone 2 Number of farmers who planted before the rain Number of farmers who planted after the rain		Zone 3		Overall
Potatoes	1.4 (1-3)	1.8 (1-5)	11 4	1.3 (1-2)	4 7	1.6 (1-5)

Order of Planting crops (Contd...)

Maize
Beans
Cabbages
Tomatoes
Cassava
Onions
Tobacco
Cotton
Mboyo
China

(For the above six crops mean ranks

Zone 1	Zone 2		Zone 3		Overall
2.0	1.5	12	1.5	1	1.7
(1-3)	(1-3)	4	(1-3)	18	(1-3)
3.3	2.7	2	2.5	1	2.8
(2-4)	(1-3)	14	(1-4)	17	(1-4)
2.4	-		-		2.4
(2-5)	-		-		(2-5)
2.7	4.5		-		3.4
(2-3)	(4-5)		-		(2-5)
-	4		-		-
-	3		-		-
2	-		-		-
-	-		1		-
-	-		2		-
-	-		4		-

only are given)

34. November 1976 dry
Too much sun
Crops spoilt

Crops spoilt

Maize
Beans
Potatoes
Coffee
Cabbages
Tomatoes
Onions
Pasture grass
Sunflower
Mboyo

Zone 1	Zone 2	Zone 3	Total
Number of farmers			
8	12	18	38
7	6	2	15
10	13	16	39
5	13	15	33
8	10	13	31
3	3	3	9
4	2	0	6
1	0	0	1
1	2	0	3
1	0	0	1
0	1	0	1
0	0	2	2
0	0	1	1

	Zone 1
35. Number of farms fenced for stock	15
Mean no of acres fenced	1.5
Range	(0.5-4)
Number of farms having cattlesheds with roof	5
No. of farmers having boma (stockade)	13
No of farms having storehouses	23
Mean no of storehouses	1.3
Range	(1-3)
Mean no. of living houses per farm	2.2
Range	(1-4)
Number of farm having separate Kitchen	10
Mean No. of kitchens per farm	1.2
Range	(1-2)

Zone 2	Zone 3	Overall
3	4	22
0.6	9.9	2.9
(0.25-1)	(0.5-24)	(0.25-24)
2	4	11
12	15	40
20	17	60
1.4	1.9	1.5
(1-3)	(1-4)	(1-4)
2.06	2.7	2.3
(1-5)	(1-6)	(1-6)
12	14	36
1.2	1.5	1.3
(1-2)	(1-3)	(1-3)

		Zone 1
	No. of farms having at least 1 corrugated iron roof	15
	Mean no. of currugated iron roofs	3.1
	Range	(1-5)
	Number of farms with a strikingly better than average living house	4
	Number of farms with chicken house/rabbit hutch	3
	No. of farms with goat/sheep house	0
	No. of farms with house or store under construction	1
	No. of farms with disused house	0
36 (a)	No. of farms having piped water supply	20
	No. of farms having piped water supply <u>in use</u>	12
(b)	Water obtained by women carrying	9
	Water obtained by donkey/ox cart	0

Zone 2	Zone 3	Overall
14	16	45
2.7	4.2	3.3
(1-7)	(1-11)	(1-11)
1	4	9
4	3	10
2	3	5
2	3	6
1	3	4
4	1	25
2	1	15
Number of farms		
19	14	42
3	5	8

37. Vehicles owned

Ox-/donkey cart

Ox-plough

Bicycle

Wheel barrow

Matatu

Lorry

38. Possessions

Watch

Clock

Radio

Sewing machine

	Number of farmers (prop)		
Zone 1	Zone 2	Zone 3	Total
3(0.13)	4(0.17)	9(0.43)	16 (0.23)
3(0.13)	4(0.17)	14(0.67)	21 (0.36)
5(0.21)	9(0.38)	5(0.24)	19 (0.28)
7(0.29)	2(0.08)	7(0.33)	16 (0.23)
2(0.08)	0 (0)	2(0.10)	4 (0.06)
00 (0)	0 (0)	1(0.05)	1 (0.01)

Number of farmers owning		(Proportion)	(prop) TOTAL
1(0.29)	7(0.29)	8(0.38)	22 (.32)
4(0.17)	1(0.04)	4(0.19)	9 (1.3)
9(0.38)	10(0.42)	11(0.52	30 (.43)
1(0.04)	2(0.08)	1(0.05)	4 (.06)

39. Age group of farmer

30-39

40-49

50-59

60-69

Over 70

Modal age group for zone

Next most frequent age group

40. Schooling of farmer

Primary School only

1.

Standard reached 2

3

4

5

6

Number of farmers			
Zone 1	Zone 2	Zone 3	Total
2	10	2	14
6	3	6	15
7	4	3	14
8	5	7	20
1	2	3	6

			Overall
60-69	30-39	60-69	60-69
50-59	60-69	40-49	40-49

Number of farmers			Total
13	16	12	41
1	0	2	3
0	1	0	1
5	3	1	9
2	1	4	7
0	4	1	5
3	2	0	5

Schooling of farmer (Contd...)		Zone 1	Zone 2	Zone 3	Total
Standard reached	7	0	1	1	2
	8	2	4	3	9
Had never been to School		9	8	9	26
Secondary School (Form 2 and form 4)		2	0	0	2

41. Attendance at farmers training centres

	Zone 1	Zone 2	Zone 3	Overall
Number of farms where at least 1 member had attended.	10	4	9	23
Mean no. of weeks (total for husband and wife)	5.1	1.5	2.6	3.5
(range)	(1-18)	(1-3)	(1-5)	(1-18)

[illegible] at other training or courses

Number of farmers [illegible]

Mean number of months (for those who could specify)

ra[illegible]

CHAPTER FOUR

RESULTS OF THE QUESTIONNAIRE
- Tables and Commentary

(i) Structure of the sample

According to maps from the Survey of Kenya, and for land registration purposes, Kabare location comprises eight sub-locations:-

Nyagithuchi, Njiku, Gachige, Mutige, Ngiroche, Kiritine, Mikarara and Nyangati.

However, for administrative purposes, the lower and largest sublocation, Nyangati is considered as part of Murinduko location in Mwea Division, and is subdivided into two sub-locations Nyangati A (also called Ndomba . which is the Northern part) and Nyangati B. Nyangati lies below the Sagana-Embu road.

Also for administrative purposes, Kiritine is subdivided into two sublocations, the upper known as Kiritine and the lower as Rukenya.

The choice of sample size was influenced by two constraints. Firstly, to avoid making spurious generalisations from too small a sample, I wished the sample size to be at least 50. Secondly, the time factor prevented the sample size from being over 80. Therefore a preliminary sample size of 66 was chosen. This was appropriately stratified in proportion to the number of land titles in each sublocation, which was found from the Land Registry at Kerugoya. Then the names and plot numbers of farmers to be interviewed were selected using random number tables, from the land registers for each sublocation. A few reserve names were drawn also for each sublocation some of which were used as substitutes in cases of difficulty. These could be if a sample farm had been bought only recently, and was not yet being farmed, if the owners were unknown by the subchiefs who were guiding us, if all the farm was hired out, if the owner was too old to answer the questions or if the owner was a businessman and could not be found. In practice about 15 such cases occurred and so substitutes for them had to be picked. Moreover, the number of farms visited in each sublocation was changed very slightly because of the practicality of planning the timetable for each day and arranging to meet sub-chiefs to guide us to the farms. Thus one more farm than the 2 originally planned, was visited in Nyagithuchi and one less than the 9 and 14 respectively originally planned in Gachige and Kiritine. This does not seriously alter the stratification, - as can be seen by comparing the proportions for the sample and the location as a whole, because the integer number of farms to be visited in each sublocation is approximate in the first instance. Time permitted 21 farms, rather than the 17 originally planned, to be visited in Nyangati. This meant that the inter-zone comparison could be facilitated since the numbers of farms in each Zone were more nearly equalised (Nyangati comprises Zone 3). These small adjustments meant that the final sample size was 69.

54. <u>Worst problems with the farm</u>

Lack of money to hire labour
Unavailability of labour
Shortage of land
Drought-lack of rain
Lack of water
Lack of money
Poor soil
Pests - insect or animals
Too much work
Obtaining fertilizer or manure
Waiting to hire a plough
Steepness of farm
Flooding on low part
Stoniness of farm
Soil erosion
Cultivating land which was recently covered in bush
Sickness
Low price for crops so make a loss
Infringement of boundary because not fenced

Zone 1	Zone 2	Zone 3	Total
Number of times mentioned			
11	11	8	30
9	1	1	11
2	3	1	6
1	9	11	21
0	6	2	8
5	3	4	12
3	3	1	7
1	4	1	6
4	10	9	23
2	0	0	2
0	0	1	1
0	2	0	2
0	0	1	1
0	1	1	2
0	1	0	1
0	1	0	1
2	2	0	4
0	0	1	1
0	0	1	1

55. Farmers' worst fears	Number of times mentioned			
	Zone 1	Zone 2	Zone 3	Total
Drought - poor harvest - famine	4	8	13	25
Lack of money to employ labour	4	4	2	10
Too much rain	5	1	0	6
Too much work	2	2	1	5
Lack of labour	2	1	0	3
Getting a loan and being unable to repay	2	1	0	3
Lack of money	1	2	1	4
Crops being destroyed by animals/pests	0	2	2	4
Rain coming too early before having prepared ground	1	0	0	1
Rain coming late	1	0	0	1
Crops not doing well because of poor soil	1	2	0	3
Flooding on low part of farm	0	1	0	1
Shortage of land	0	1	0	1
Infringement of boundaries	0	0	5	5
Sons taking over the farm	0	0	1	1
Keeping cattle because drought destroys pasture	0	0	1	1

Farmers owning oxen and having definite income from ploughing these long rains

Number of farmers

Mean charge Kshs/acre (range)

Mean income (range)

Mean no. acres ploughed (range)

No. of additional farmers who own oxen and may have income from ploughing

Farmers owning oxen and having definite income from ploughing last short rains

Charge/acre

Income

No. of acres ploughed

Number of farmers having income from house/shop rent

Mean income/re

range

Zone 1	Zone 2	Zone 3	Overall
1	0	3	4
35	0	67(60-70)	59(35-70)
175	-	137(60-210)	146(60-210)
5	0	2(1-3)	2.75(1-5)
1	5	8	14
-	-	70	70
-	-	175	175
-	-	2½	2½
0	0	3	3
0	0	100/-	100/-
-	-	(20-200)	(20-200)

Attendance of other training or courses (Contd...)	Zone 1	Zone 2	Zone 3	Overall
Number of farmers	5	4	8	17
Mean number of months (for those who could specify)	25.5	19.3	13.5	17.0
(range)	(24-27)	(6-28)	(0.5-24)	(0.5-28)

42. Employment of immediate family members (owner, wife or children)	Zone 1	Zone 2	Zone 3	Overall
Regular employment				
Number of farms having at least 1 family member employed.	13	13	18	44
Mean number of family members employed	1.5	1	1.9	1.5
(Range)	(1-3)	-	(1-6)	(1-6)
-Skilled	6	8	10	24
	1.5	1	2.3	1.7
	(1-2)	-	(1-6)	(1-6)
-Unskilled	7	5	8	20
	1.6	1	1.4	1.4
	(1-3)		(1-2)	(1-3)

Employment of immediate family (Contd..)	Zone 1	Zone 2	Zone 3	Overall
Casual employment	1	2	2	5
	1	1	1	1
	-	-	-	-

43. Other lucrative occupations of immediate Family members	Number of farmers			Total
Owning or part owning a duka	3	1	4	8
Owning or part owning a matatu	3	0	2	5
Other business	1	1	0	2
Son has own farm	1	0	2	3

44. Helping relatives or neighbours without pay	Number of farmers			
Helped, were helped in return	7	3	2	12
Helped others, but no help given in return	4	1	0	5
Were helped but gave no help in return	0	6	0	6

45. (a) Family members living on the farm

MEN

WOMEN

CHILDREN

Other people living on the farm

Men

Women

Zone 1	Zone 2	Zone 3	Overall
Mean (range)			
1.6	1.5	1.5	1.5
(0-4)	(0-3)	(0-5)	(0-5)
1.5	1.8	1.9	1.7
(1-3)	(1-6)	(0-7)	(0-7)
5.0	5.2	4.1	4.8
(2-10)	(0-15)	(0-9)	(0-15)
Number of farms having at least 1 non-family member living there.			
Mean no. of non-family members (range)			
6	4	7	17
1	1.5	1	1.1
-	(1-2)	-	(1-2)
1	0	3	4
2	-	1	1.3
-	-		(1-2)

Other people living on the farm (Contd..)

Children

---

45 (b) Family members working on the farm everyday

Men

Women

Other people working on the farm

Men

Zone 1	Zone 2	Zone 3	Overall
0	1	3	4
-	1	1	1
-	-	-	-

Number of farms

Mean

(Range)

13	18	14	45
1.7	1.1	1.5	1.4
(1-4)	(1-2)	(1-3)	(1-4)
1.4	1.6	1.8	1.6
(0-3)	(0-5)	(0-4)	(0-5)

Number of farms having at least 1 non-family member working there

Mean no.

(range)

5	2	4	11
1.4	1.5	1.3	1.4
(1-2)	(1-2)	(1-2)	(1-2)

Other people working on the farm (Contd..)

Women

Children

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46. Casual Labour hired 1976

Ploughing only, in long rains

Number of farms

Mean number of man-days

(range)

Ploughing and planting, in long rains

Number of farms

Mean number of man-days

(range)

Zone 1	Zone 2	Zone 3	Overall
1	0	1	2
2	-	1	1.5
-		-	(1-2)
0	0	1	1
-	-	1	1
-	-	-	-

Zone 1	Zone 2	Zone 3	Overall
6	11	3	20
6.5	9.1	8.3	8.2
(3-9)	(3-24)	(4-12)	(3-24)
0	2	7	9
0	40	12.0	18.2
-	(8-72)	(2-36)	(2-72)

Ploughing only, in short rains

Number of farms

Mean number of man-days

(range)

Ploughing and planting, in short rains

Number of farms

Mean number of man-days

(range)

Tractor, long rains

Number of farms

Mean number of man-days

(range)

Coffee picking

Number of farmers who hired coffee pickers

Approximate mean number of man-days per year

Zone 1	Zone 2	Zone 3	Overall
5	3	1	8
6.5	10.2	9	8.3
(3-11)	(5-15)	-	(4-15)
0	0	3	4
0	0	18	14.3
-	-	(9-30)	(3-30)
0	0	3	3
-	-	3.2	3.2
-	-	(1-6)	(1-6)
10	10	0	20
122	108	-	111

Tea picking

Number of farmers employing tea pickers

Approximate mean number of man-days per year

Weeding

Number of farms

Mean number of man-days per year (range)

Harvesting

Number of farms

Mean number of man-days per year (range)

Preparing the ground by hand

Number of farms

Mean number of man-days per year (range)

Zone 1	Zone 2	Zone 3	Overall
7	0	0	7
731			731
5	6	7	18
39	48.3	26.2	37.5
(18-60)	(1½-104)	(6-60)	(1½-104)
3	2	8	13
92	43	83.3	78.8
(2-260)	(26-60)	(5-351)	(2-351)
2	4	0	6
14	52	0	39.3
(4-24)	(8-156)	-	(4-156)

		Zone 1
	Planting	
	Number of farms	0
	Number of man-days	-
47.	Number of farms with children at Nursery School	9
	Mean no. of children per farm in nursery school	1.3
	Range	(1-3)
	Number of farms with children in Day School - Standard 1-4	20
	Mean no. of children per farm in Standard 1-4	20
	Range	(1-4)
	Number of farms with children in Day School - Standard 5-7	13
	Mean no. of children per farm in Std. 5-7	1.5
	Range	(1-3)

Zone 2	Zone 3	Overall
0	1	1
-	39	39
12	6	27
1.1	1	1.2
(1-2)	-	(1-3)
16	17	53
2.00	2.1	2.00
(1-4)	(1-4)	(1-4)
10	10	33
2.1	2.1	1.9
(1-6)	(1-6)	(1-6)

Number of farms with children at

Day Primary School

Mean no. of children per farm at
Primary School

Range

Number of farms with children at

Boarding Primary School

Mean number in Std. 1-4 (Range)

Number in Std. 5-7

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48. Number of farms with children at

Day Secondary School - Form 1-4

Mean number of children in form 1-

(range)

Number of farms with children at

Boarding Secondary School in Form

Mean no. of children in Form 1-4

(range)

	Zone 1	Zone 2	Zone 3	Overall
	22	17	19	58
	2.7	3.1	3.0	2.9
	(1-5)	(1-10)	(1-9)	(1-10)
	0	0	2	2
	0	0	range 2(1-3)	2(1-3)
	0	0	1	1

	3	3	4	10
-4	1	1	1.8	1.3
	-	-	(1-4)	(1-4)
1-4	8	2	7	17
	1	1	2.3	1.5
	-	-	(1-4)	(1-4)

Number of farms with children at Secondary School Form 1-4	Zone 1	Zone 2	Zone 3	Overall
	9	5	9	23
Mean no. of children in Form 1-4	1.2	1	2.6	1.7
(Range)	(1-2)	-	(1-6)	(1-6)

49. Number of farmers who paid school fees for other relatives	Zone 1	Zone 2	Zone 3	Total
	1	2	1	4
Mean number of children	3	1.5	1	1.75
Range	-	(1-2)	-	(1-3)

50. Other big expenses apart from school fees and things for the farm	Number of times mentioned			
Clothing	22	19	15	56
Household expenses	17	12	10	39
Food (and drinks)	15	15	8	38
Sickness	1	7	2	10
Building	2	0	3	5

Other expenses mentioned were:

helping relatives; dog food; books for a private student; travelling; school uniform; bride price; contributing to a community fund.

51.	Number of farmers who keep money in a bank	Zone 1	Zone 2	Zone 3	Total
		5	0	1	6
	Number of farmers who only have a bank account for coffee, milk or tea payments	15	20	3	38
	Number of farmers who didn't know	1	0	1	2

52.	LOANS of money or in kind obtained last year (1976)	Number of recipient farmers			
	Loaning Agent				
	Kabare Coffee Co-operative Society	12	19	2	33
	KTDA	11	0	0	11
	Kirinyaga Cotton Produces Co-op. Soc.	0	0	1	1
	Bank	2	0	0	2

	Loans of materials from Kabare Coffee Co-op. Society, KTDA or Kirinyaga Cotton Producers Society	Number of recipient farmers			
	Fertilizer	20	13	1	34
	Fungicide	9	10	1	20
	Insecticide	7	7	0	14

Loans of materials (Contd...)	Zone 1	Zone 2	Zone 3	Total
Maize seeds	7	16	2	25
Coffee seedlings	0	1	0	1
Spray pump for cotton	0	0	1	1
Loans of money obtained in 1976 from Kabare Coffee Co-op. Soc. (or Bank)				
Number of recipient farmers	11	5	2	18
Mean amount of loan (Kshs.)	1895	1260	26,000	3976
range	(1200-3000)	(200-2400)	(2000-50,000)	(200-50,000)
Purpose for which the loan of money was given		Number of farmers		
Building	1	1	0	2
To buy manure	5	0	0	5
To buy a cow/goats	0	2	0	2
Paying hired labour	2	2	0	4
For school fees	1	0	0	1
Fencing	0	0	1	1

Purpose for which the loan of money was given (Contd..)	Zone 1	Zone 2	Zone 3	Total
	Number of farmers			
To buy another farm	1	1	0	2
Transport	1	0	0	1
Stores for duka	0	0	1	1

Note on uses of loans

Two farmers used loans intended for building and buying manure, to pay school fees.

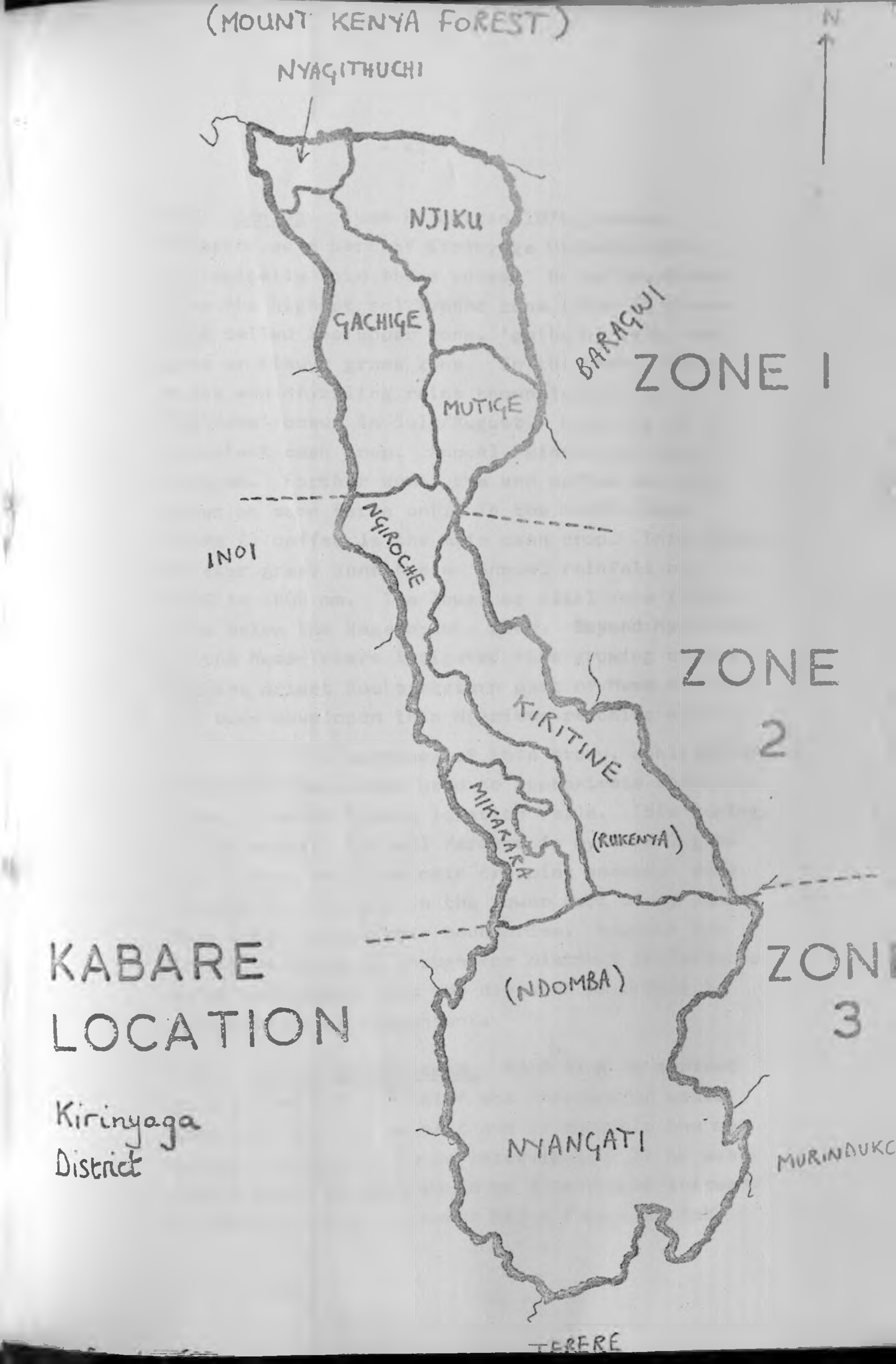
One farmer used a loan intended to buy a cow with to pay medical expenses.

One farmer used a loan intended to pay hired labour for weeding, to buy clothing and food for his family who did the weeding instead.

53. Activities taking place on the farm during the week in which the interview was conducted

Activities taking place on the farm during the week in which the interview was conducted	Zone 1	Zone 2	Zone 3	Total
	Number of farms			
Tea picking	16	0	0	16
Spraying coffee	5	0	0	5
Pruning coffee	0	3	1	4
Digging and preparing ground by hand	13	11	6	30
Removing rubbish	2	6	3	11
Ploughing	1	5	11	17
Planting	2	4	16	22
Weeding	9	2	0	11
Harvesting maize	4	4	2	10
Spraying potatoes	0	1	0	1
Putting manure on coffee	1	0	0	1

Note: (More than one of such activities may have been taking place on any one farm)



(MOUNT KENYA FOREST)
N
NYAGITHUCHI
NJIKU
GACHIGE
BARAGWI
ZONE 1
MUTIGE
NGIROCHE
INOI
ZONE 2
KIRITINE
MIKARARA
(RUKENYA)
KABARE LOCATION
Kirinyaga District
ZON
3
(NDOMBA)
NYANGATI
MURINDUKO
TERERE

(ii) Zoning. (van Eijnatten 1975). Kabare location as a part of Kirinyaga District, falls ecologically into three zones. Below the forest lies the highest cultivated zone (Zone 1) otherwise called the upper zone, 'gathano' zone, tea zone or Kikuyu grass zone. In this zone, heavy mists and drizzling rains known locally as 'gathano' occur in July/August. Here tea is an important cash crop. Annual rainfall is 1600 - 1900 mm. Further down, tea and coffee are both grown on some farms until in the middle zone (Zone 2) coffee is the main cash crop. This coffee or star grass zone has an annual rainfall of 1200 to 1800 mm. The lower or sisal zone (Zone 3) lies below the Sagana-Embu road. Beyond Nyangati is the Mwea-Tebere irrigated rice-growing scheme and the driest South-eastern part of Mwea division has been developed into Ngariama ranching scheme.

For the purposes of this study, sublocation boundaries have been used to approximate the three zones in which Kabare location falls. This zoning is not exact: not all farmers in my Zone 1 grow tea or have only one main cropping season; some farmers in Rukenya, in the lower part of my Zone 2 have sisal round their boundaries; however the Zoning is accurate enough for distinct differences to be noticeable, and the division according to sublocations is convenient.

(iii) Person interviewed. Each time we arrived at the farm the sub-chief and interpreter would ascertain who was present and if possible the man owning the farm would be interviewed. If he was absent then the wife would be interviewed instead. In several cases the owner had a full-time job away from the farm, sometimes not even living there, and, then it was the wife who managed the farm. Best results were obtained when both husband and wife were there as they could give complementary information. When a farm was divided among wives or between a father and sons, we interviewed only one of the cultivators, usually the one who cultivated the largest part.

(iv) Possession of another farm During the course of some interviews it was discovered that a few farmers possessed more than one farm. This happened rarely in Zone 1 but more frequently in Zone 2 and Zone 3. Most farmers were asked whether they did possess another farm, if they had not said so themselves, and then it was attempted to obtain information on acreages of crops grown etc. for both farms together. In a few cases, farmers were re-interviewed to establish this information.

(v) (a) Acreage hired from others A few farmers hired land from others, especially to cultivate in the long rains. Information on this is not quite complete, but the hiring happened more in Zone 3 than in the other zones, and most farmers were asked if they hired any land from others. If they did, they were then asked what crops they grew on it etc. so that that land could be combined with their own, as their total enterprise.

(b) Acreage hired to others. For the farmers in the sample, hiring part of the farm out to others seemed to happen more frequently than hiring land from others but took place in the two lower zones only.

(c) The charge per acre per season varied with the quality of the land and the length of contract. The means given are calculated from the prices quoted by both the farmers who hired from others and to others.

Reference:

van Eijnatten, C.L.M. (1975) Report on a literature review and field study of agriculture in Kirinyaga District with special reference to beans. University of Nairobi, Department of Crop Science, Technical Communication 13 .

Note: Only some of the questions, those which are not self-explicit, will be commented on. Results for a few questions in the questionnaire have not been tabulated.

1. (a) Since the farms were a random sample picked from the title deeds, the acreage of each farm could be obtained both from the record in the land register and by asking the farmer himself. Some records in the land register, dating from the original adjudication were in acres, more recent sub-divisions or combinations were in hectares. Since the farmers gave the areas both of the farm itself and of crops grown, in acres, it was decided to work completely in acres. There was usually only a small discrepancy between the acreage stated by the farmer (usually to the nearest whole acre) and that in the title deeds (usually to the nearest 0.1 acre). In cases of a large discrepancy the title deeds were re-checked, and for only about 7 out of the 69 farms were these discrepancies not resolved.

For the purpose of subsequent calculations of proportions of the farm devoted to cash crops, the farmer's own statement of total acreage was used, since the farmer stated his own crop acreages.

Farms in Zone 3 tended to be considerably larger than in the other two zones. Farms in zone 2 tended to be more uniform in size than in zone 1 or zone 3.

(b) The farm was not counted to be divided if the coffee or tea, for example, was divided among father and sons, but only if the food crops were grown separately by different cultivators. In the case of divided farms, it was usually the main cultivator who was interviewed, and the mean size of piece given to relatives refers to the pieces cultivated by persons other than the main cultivator. For farms divided into more than two, the mean size of the pieces not cultivated by the main cultivator was computed. This was counted only once when the mean size of piece given for the zone or overall was calculated.

Such division took place more frequently, and among a larger number of people in lower than in higher zones.

(c) These acreages differed slightly between the short rains 1976 and the long rains/1977 in zones 2 and 3 because the amounts hired from and to others sometimes varied between the two seasons. Later when the proportion of cash crop was calculated, this difference was taken into account, and a mean proportion obtained.

2. The majority of farmers had obtained their land at adjudication (in the late 1950's).

3. (a) In zone 3 one farmer did not know for how long he had lived in Kabare location, hence the total number of responses is only 20 although there are 21 farmers in the sample in zone 3.

Most farmers had lived in Kabare location from birth.

(b) The number of years lived on that farm could be checked from the title deeds. There was seldom much discrepancy between the record in the title deeds and the farmer's answer, and it is the farmer's answer which is tabulated here.

Most farmers had been on their farm since the land was adjudicated in the late 1950's. (the year varied slightly between sub-locations)

The farmers' own definition of 'near' was taken. It would approximate to 'within the same location'

(c) In zones 1 and 2 the proportion of farmers who had relatives (including clan members) living near to their farm was high. It was somewhat lower in zone 3. This might be because zone 3 was adjudicated later, and people generally moved on to the land there from higher areas, where in zones 1 and 2 the people had often been farming the land there before adjudication.

4. In this table <u>skilled</u> work refers to any type of work which requires training, such as teacher, nurse, mechanic, clerk, painter, builder, policeman, shoemaker, agricultural field worker, coffee factory supervisor, driver.

<u>Unskilled</u> work refers to any type of work which does not require training such as trader, turnboy, barman, cook, house-servant, labourer, messenger.

Many of the farmers had had jobs when they were younger, perhaps in Nairobi, and had then come back to the land.

5. Here grade cows includes 'half-caste' or improved local breeds. Most of the farmers in zone 1 had grade cows but local cows were predominantly found in the lower zones, as were oxen.

6. In the lower zones more goats and fewer sheep were found whereas in zone 1 more sheep and fewer goats were found.

   Only two farmers in the whole sample had pigs, and only a few farmers had donkeys, none of them in zone 1.

7. Most farmers gave the number of coffee or tea stems they had, rather than the acreage. These were converted to fractions of an acre using the spacings of 9ft x 9ft for coffee (which is equivalent to 538 plants/acre) and: 2½ft x 5ft for tea (3485 plants/acre)*

   A few farmers were planning to add coffee or tea stems during the long rains of 1977 and this has been taken into account when calculating the proportion of cash crop for each of two seasons. However these tables give the existing coffee or tea acreage.

*Source: Kirinyaga District Guidelines 1976.

Tea was only grown in Zone 1 and then only by two-thirds of the farmers in the sample.

Coffee was grown by most of the farmers in both Zones 1 and 2 but not in Zone 3, apart from three farmers who owned coffee on a relative's farm in a higher area.

All the farmers in the sample in Zone 1 had planted pasture grass but the proportion with planted pasture grass decreased in the lower zones.

Most farmers gave approximate fractions of an acre for bananas grown, but where they gave number of stems instead, the approximate spacing of 350 plants/acre was used. However, the spacing for bananas is much more variable than that for tea or coffee, which are standard. The reason is that some farmers grow bananas pure stand while others plant bananas at a much wider spacing with seasonal crops grown in between.

The proportion of farmers growing bananas was highest in Zone 2, but in Zone 3 it was considerably lower than in the other two zones. Many farmers in Zone 3 had tried to grow bananas but the crop had failed because of lack of rain.

The proportions of farmers growing sugar cane did not differ markedly between the zones, but the mean acreage was much higher in Zone 3 than in the other zones.

Mangoes were grown by a much higher proportion of farmers in zones 2 and 3 than in

Zone 1. In the lower part of Zone 2 and in Zone 3 the mango trees grew very large.

Oranges were grown by a much higher proportion of farmers in Zone 2 than in either of the other two zones, whereas the proportion of farmers growing passion fruit decreased substantially from Zone 1 to Zone 2 to Zone 3. Avocado was grown mainly in Zone 2, while tree tomatoes were only found in Zone 1.

Every farmer in Zone 3 grew sisal round the boundary, as did the farmers in the lower part of Zone 2 but sisal was not grown in Zone 1.

Arrowroot seemed to be a more important crop for the farmers in Zone 1 than in any other Zone, and yams were grown less in Zone 3 than in the other two Zones.

9. Short rains planting 1976

The acreages of seasonal crops were as given by the farmer, sometimes with the help of the sub-chief . Most farmers seemed to have a good idea of these acreages.

In the short rains of 1976, the proportion of farmers growing maize increased steadily from Zone 1 to Zone 2 to Zone 3 and the mean acreage in Zone 3 was almost twice that in Zone 1. Beans were grown by a smaller proportion of farmers in Zone 3 than in Zone 1 or Zone 2 although again the mean acreage was highest in Zone 3. The proportion of farmers who grew maize/bean mixture was higher in Zone 1 than in either of the other zones, although the mean acreage of maize and beans grown was considerably higher in Zone 3 than in either Zones 1 or 2. The proportion of farmers who grew potatoes in the short rains of 1976 was highest in Zone 2 and lowest in Zone 1, because in Zone 1 the farmers who experience the 'gathano' rains of July/August (classified with the short rains for these purposes) do not plant potatoes then but usually only in the long rains of March/April. However the mean acreage of potatoes is highest in Zone 1. Few farmers in any zone grew cabbages in the short rains.

The smallest proportion of farmers growing tomatoes was in Zone 3, because of lack of water. Cowpeas appeared to be grown more frequently in Zone 2 than in either of the other two zones, but the acreage grown was usually very small in all zones.

Sunflower was only grown in Zone 3. It had been introduced only last season by agricultural extension staff, as there was a new oil processing plant at Kimbimbi. Similarly, cotton was only grown in Zone 3. It lasts for a whole year but can be planted in either season.

Maize and cowpeas (and beans) were only mixed in Zones 2 and 3, and it was also only in those zones that sorghum was planted in the short rains. Most farmers only planted sorghum in the long rains, as the crop lasts for a year, and some of the farmers recorded here as having planted it in the short rains 1976 may actually have meant that they had planted it in the long rains 1976 and were only just harvesting it at the time of interview in February/March 1977.

Cassava seemed to be most frequently grown in Zone 2. Very few farmers grew carrots, onions, pumpkins or tobacco, and the tobacco was only grown in Zone 1. Black grams, yellow grams and green grams were only grown in Zone 3.

10. Long rains planting 1977

More farmers grew maize in the long rains than in the short rains, and the acreages planted were higher. Fewer farmers in Zone 1 planted beans in the long rains than the short rains, because of the danger of too much rain, and the mean acreage planted was smaller, but for the other two zones, the number of farmers planting beans increased in the long rains. Again fewer farmers in Zone 1 grew maize and beans mixed in the long rains than in the short rains. This was mainly because the farmers in the Northern part of Zone 1 only plant maize and beans once a year, in the 'gathano'rains of July/August, and only plant potatoes and cabbages during the long rains of March/April. However, for Zones 2 and 3 the proportion of farmers growing maize/bean mixture increased in the long rains.

In all zones, more farmers grew higher acreages of potatoes in the long rains than the short rains, and for Zone 1 the number of farmers growing cabbages increased markedly in the long rains and the mean acreage also increased. The number of farmers in Zones 2 and 3 who planted maize/beans/cowpeas mixture, and sorghum increased in the long rains. One farmer in Zone 3 planted wheat in the long rains.

The mean proportion of the farm fallow was calculated from the data on acreages of perennial and seasonal crops in questions 7, 9 and 10. For each season the total acreage of perennial and seasonal crops was added, and then the result was subtracted from the total acreage for which the family living on the farm was responsible (=total acreage owned + acreage hired from others - acreage hired to others)
to give the acreage which was fallow. This, divided by the total acreage for which the family living on the farm was responsible, gave the proportion of the farm fallow. For divided farms, the total acreage of perennial crops was known since these are usually considered as belonging to the family as a whole, but the acreage of seasonal crops was only known for the major cultivator who was the person interviewed. In nearly all cases the acreages given to others to farm were known, so it was assumed that these were devoted entirely to food crops, unless we had been told otherwise. Therefore the extra cultivated acreage was allocated to maize and beans in each season either mixed or pure stand, following the pattern set by the major cultivator. This enabled the acreage data for the 21 divided farms to be considered for the whole farm and

thus it was made comparable with the data for the 48 other undivided farms.

Sometimes the acreage left fallow turned out to be negative because the farmer had overstated his crop acreages. This situation is also tabulated, but for the purpose of calculating the proportion of the farm fallow, such farmers were considered not to have any fallow land.

The mean proportion of the farm fallow increased from Zone 1 to Zone 2 to Zone 3 in both seasons, and in both Zones 2 and 3, it was markedly higher in the short rains than in the long rains, because the probability of rain failing in the short rains there was much higher, whereas in Zone 1 there was usually sufficient rain in both seasons.

Since only a few farmers in each Zone overstated their crop acreages, and the proportion by which the acreage was overstated by them was usually not high, no adjustment was made to the data for the purpose of subsequent calculations. In fact most subsequent calculations were of proportions, which would be largely unaffected by the over-statement since both numerator and denominator would be too high.

Note: The reasons for mixing crops, and other reasons given in the questionnaire, were given as answers to open-ended questions. The farmer was left to think of his own reasons rather than being offered alternatives to which to acquiesce. There were three reasons for using this open-ended questionning procedure. Firstly, it would have been difficult **a priori**, to think of all the alternatives which the farmer might give. Secondly, it would have been difficult to explain the process of choosing an alternative to each farmer for each question. Thirdly, and most importantly, it was considered that substantial bias would be introduced by offering the farmer ready-made alternative reasons, even if the procedure would have been workable. After the survey, the answers to all such open-ended questions (Numbers 12, 13, 14, 15(b), 16 (b), 17(b), 19(b), 26(b), 31(b), (c), 54, 55) had to be classified into a small number of alternative answers.

Obviously the fact that such answers had to pass via an interpreter slightly reduces their accuracy, but this is not considered to be a serious limitation.

Once the alternative answers had been tabulated for each of these open ended questions, they had to be screened to see whether they were risk-neutral or gave any information as to the farmer's attitude towards risk.

Note: 'Number of times mentioned' implies that the farmers might have mentioned more than one reason. Therefore the Zone Totals need not add to the number of sample farmers in the Zone.

12. Here, alternatives (c) and (d) were considered to be risk-averse, (c) more explicity so than (d) since (d) is simply very conservative,

while (e) was considered to be risk-taking and the other replies were deemed to be risk-neutral. Many farmers, especially in Zone 1, seemed to consider crop mixtures to be super-imposed fields of pure stand and thus a way of reducing the land constraint.

14. Here alternative (c) was considered to reveal risk-aversion.

15. (a) (i) For Zones 1 and 2 most farmers considered coffee to be the most profitable crop, whereas for over half the farmers in Zone 3, maize was considered the most profitable. In Zone 1, over half the farmers who grew tea considered it to be the most profitable. Four of them did not grow coffee, but the other five thought tea more profitable than coffee.

(ii) The remaining farmers who grew tea considered it to be second in profitability to coffee, and those who grew both coffee and tea, who had put tea as the most profitable, put coffee second. Beans were an important crop for profitability in Zone 2 (where they were mainly second to coffee) and in Zone 3 (where they were second mainly to maize.) In those two zones, maize was also a fairly important second-most-profitable crop, whereas dairying was an important enterprise in Zone 1.

(iv) For each crop, the total score for profitability was found by adding the points derived from whether each farmer had mentioned it as 1st, 2nd, 3rd, 4th or 5th most profitable, or had not mentioned it at all, the scoring system used being given in the table.

(v) By ranking these scores a useful summary of profitability is obtained for each Zone and overall.

15(b) The most frequent reasons for not growing more of these most profitable crops were shortage of land and shortage of labour. Unsuitability of climate and already having sufficient of the crop were also important reasons in Zones 3 and 2, and lack of money was important in Zone 2.

Again, each farmer might give more than one reason.

16. There is a great variety of crops which had been recently introduced by farmers. None of these crops is very new to the area apart from sunflower in Zone 3, which had been introduced by agricultural extension staff in 1976. Notable among the reasons for adopting these new crops were to experiment, or because the crop had a good price or would be good for food.

17. Many farmers in Zone 1 had recently given up growing sorghum and millet because the birds tended to eat the heads and they did not have enough labour to scare the birds as well as performing the other farm duties. The other

crops recently given up were quite varied. Predominant reasons for ceasing to grow these crops were that they had been much destroyed by pests or diseases or the climate was unsuitable (these reasons were considered to be risk-averse but all the other reasons appeared risk-neutral) and that too much labour was needed.

18 (a) At the beginning of the period of interview some farmers had not yet completed harvesting maize, so it would not be included among the crops in store for them, whereas it was included for farmers interviewed later in March. Other crops, however, had already been harvested. Maize is usually stored not in bags but on the cob, However the farmers gave an estimate of how many bags the shelled grain would fill. This applies also to sorghum. Therefore the figures for beans and potatoes, which are stored in bags, are more reliable than for maize and sorghum, which are estimates by the farmer. Amounts of sorghum stored were usually given in debes. These were converted to bags by using 6 debes ≡ 1 bag but then the figures, which were only approximate in the first instance, were corrected to one place of decimals.

A high proportion of farmers in Zones 1 and 2 stored maize and beans.

(b) Most farmers used an insecticide on their stored crops, otherwise much would have been lost by pest damage, and most farmers would have stored greater amounts if they did not have the difficulties of pests and lack of space. Only about half the farmers in Zones 1 and 2 had difficulty in storing if they had large amounts, and for Zone 3 lack of space was not usually a constraint because drought often prevented them from harvesting large amounts.

19. (a) For maize, beans and potatoes, neither the proportion of farmers buying, nor the amounts bought, varied substantially between the zones. However, the proportion of farmers buying cabbages was much lower in Zone 1 than in the other two Zones, because many farmers in Zone 1 grew their own. The mean amount of cabbages bought in Zone 3 was much lower than in the other two Zones.

A smaller proportion of farmers bought milk in Zone 1 than in the other two Zones, and the amount bought was less. This is because most farmers in Zone 1 had grade cows. The amounts bought were given in terms of bottles/day and converted into annual figures.

(b) The main reasons for not producing more of these foods on their own farm were climate or soil unsuitable or pests destroyed, (especially in Zones 2 and 3),shortage of land and shortage of labour. The first-mentioned reason was taken to be risk-averse, the others were considered risk-neutral.

20. Most farmers in Zones 1 and 2 sold coffee, the mean amount sold being substantially higher in Zone 1 than Zone 2. The three farmers in Zone 3 who each grew coffee on a relative's farm higher up, sold a mean amount comparable with the farmers in Zone 1.

Tea was only sold by farmers in Zone 1. A higher proportion of farmers in Zone 3 sold maize than in the other two zones, and the mean amount sold in Zone 3 was considerably higher. The farmers in Zone 3 were not able to grow perennial cash crops on their farms so maize became their main cash crop. The numbers of bags of maize sold would be more accurately measured than the numbers of bags of maize stored.

The mean amount of beans sold was lower in Zone 2 than in either of the other two Zones, and the mean amount of potatoes sold declined steadily from Zone 1 to Zone 2 to Zone 3.

The quantities of milk sold were given in different units: some in bottles, some in kilos, some in gallons, depending on where the farmer had sold the milk and some were daily figures, some monthly. The quantities sold also varied during the year but it was attempted to find out how from the farmers. The figures given in the table are annual estimates calculated using

1 bottle ≈ 750ml 1 gallon ≈ 4.5 kg ≈ 4.5 litres.

The proportion of farmers selling milk was higher in Zone 1 than in the other two zones again because most farmers in Zone 1 possessed grade cows, although the mean amount sold was highest in Zone 3, reflecting the fact that farmers in Zone 3 who owned cows tended to own larger numbers than in the other two zones.

The numbers of whole bunches of bananas sold are very rough estimates, but they suffice to show that bananas are more important as a cash crop in Zone 2 than in either of the other two zones.

The figures for sales of tomatoes were given by some farmers in kg, by some in shillings received, and some farmers who had sold in small amounts throughout the year estimated how many bags would have been filled. The approximate conversion factors used to bring all the amounts to kg therefore, are shown at the tope of the table. A higher proportion of farmers sold tomatoes in Zone 1 than in either of the other two zones and the mean amounts of tomatoes sold were highest in the upper two zones. Zone 1 was the only zone where an appreciable proportion of farmers sold cabbages, whereas mangoes were only important for selling in the lower two zones. The amounts given for mangoes are only approximate: they would be sold in small quantities throughout the year and the farmers would estimate how many bags per year this would be. This applies also to oranges, lemons and avocados.

21. As explained for question 18, the amounts of maize and sorghum kept in 1976 would be less accurately given than the amounts of beans and potatoes. This question was hard to explain to the farmers especially if they harvested twice a year, but great efforts were made to ensure that they added the amounts from both harvests. In practice farmers in the higher part of Zone 1 only harvested each crop once per year, and farmers in the lower part of Zone 2 and in Zone 3 often did not plant in the short rains or if they did the yield was poor and they did not store any. Therefore few farmers actually harvested and stored twice a year. They were in the lower part of Zone 1 and the upper part of Zone 2. Cabbages and tomatoes, although mentioned in the question, were not counted since they cannot be stored and it would have been impossible from one visit to ascertain the amount consumed over the whole year. Nearly all farmers stored maize and beans and the mean amount stored did not vary substantially from zone to zone. The proportion of farmers who stored potatoes declined steadily from Zone 1 to Zone 2 to Zone 3, and the mean amount of potatoes stored was highest in Zone 1. Sorghum was only stored in the lower two zones and again the quantities stored were small and were usually given in debes rather than bags.

An attempt was made to discover the amount of milk produced by cows on the farm which was consumed over the whole year. Again this would vary throughout the year, so the figures are estimates. The mean amount was considerably higher in Zone 1 than in either of the other two zones, and the proportion of farmers who consumed milk from their own cows was highest in Zone 1 and lowest in Zone 2.

23. The highest proportion of farmers who gave maize to relatives was in Zone 2, but for beans the proportions were almost the same in each zone. Neither the amounts of maize nor beans given varied much between the zones, they would be fairly approximate figures. For potatoes, the proportion of farmers who gave did not vary much between the zones, but the amount given was highest in Zone 1.

The quantities of other foods given would be very approximate. Milk and cabbages were given mainly by farmers in Zone 1; bananas and mangoes mainly by farmers in Zones 2 and 3.

24. The most common exchanges which took place were maize and potatoes, beans for beans, beans for salt and Katumani maize and local maize. 'and' here means the exchange could be in either direction: 'for' means the first-mentioned item was given and the second-mentioned received. Beans for beans means either different varieties; or the

same variety, for planting at different times of year, between people in different zones. Usually equal quantities were exchanged except where crops were exchanged for salt, when less salt would be received than crop given. These quantities were small and the proportion of farmers exchanging was small, so barter was obviously not important for the farmers in Kabare: most items would be bought or sold using money as the medium of exchange.

25. The majority of farmers in Zone 1 and, to a lesser extent, Zone 2, grew only hybrid maize, and the majority of farmers in Zone 3 grew all three types: Hybrid, Katumani and local. Hybrid maize was grown by almost all farmers in the sample, the main reason for this being that it had a heavy cob and gave better yields. If Katumani maize and local maize were grown also this was because they tended to ripen earlier or were not so affected by pests or adverse weather conditions, and some farmers preferred local maize to eat. The types of hybrid maize grown varied according to the zone, 613 being the main one used in Zone 1, 512 the main one used in Zone 3, and combinations of these being used in Zone 2. When the farmers combined different types of maize they did not mix all the seed, but grew patches of each. Such combination was considered a good indication of risk aversion since each type could have desirable characteristics under different circumstances.

26. Most of the farmers in Zones 1 and 2 were members of Kabare Coffee Co-operative Society, and two-thirds of the farmers in Zone 1 sold tea to K.T.D.A.; membership of these societies was automatic if coffee or tea were grown. Almost half the farmers in Zone 1 belonged to Gichugu Dairy Co-operative Society.

The main advantages that such membership brought were that the farmers were helped to sell their produce, and given good payments, and that they could also be given loans of money, inputs or food. The Kabare Coffee Co-operative Society was the main source of such loans and also played an important role in distributing fertilizer, seed, insecticide and fungicide to the farmers. The farmers in the lower part of Zone 2 and in Zone 3, who did not have coffee, were clearly at a disadvantage in this respect, as is shown by the low proportion who used chemical fertilizers, fungicide and insecticide (see the tables for questions 27, 28 and 29)

27. Most farmers in Zones 1 and 2 used chemical fertilizer or at least one crop, the main crops on which it was used being maize, coffee, potatoes and tea.

28. Most farmers in all zones used manure, mainly on maize, potatoes and coffee.

29. Most farmers in the upper two zones used

fungicide, mainly on coffee, potatoes and tomatoes.

Insecticide was also used by most farmers in the two upper zones, mainly for maize.

Note: The data on which crops the farmer used these inputs for may be incomplete because of the phrasing of the question. The farmer was not given a checklist of all crops to see if he used each input on them, he was simply asked to name the crops and he may not always have mentioned them all. However this is not serious because he probably mentioned the most important ones every time.

Farmers in Zone 1 sprayed their coffee more frequently than those in Zone 2. This was in accordance with official recommendations. In upper areas there was more likelihood of Coffee Berry Disease, so farmers were encouraged to spray about 11 times per year, or perhaps less if the weather was fine. The mean for farmers in Zone 1 was under half that number of times. In the lower areas the farmers were encouraged to spray 3-4 times per year against leaf-rust.* The sample farmers in Zone 2 sprayed approximately that number of times.

*Personal Communication: Mr. Josphat Wambugu, Secretary/Manager - Kabare Coffee Co-operative Society.

Very few farmers kept their own written records. However tea, coffee or milk sales were recorded for them at the factory. Any records kept by farmers were about sales of crops, although one farmer had kept records to compare the yields of crop mixtures with those of pure stands.

30. The highest proportion of farmers who hired oxen for ploughing was in Zone 2. In Zone 1 most farmers prepared the ground by jembe while in Zone 3 most farmers had their own oxen. In Zone 3, those who did hire oxen usually hired them for ploughing and planting together. The mean number of days per year for which oxen were hired in Zone 3 was over twice that in either of the other two zones, reflecting the fact that the acreages of the farms in Zone 3 were larger.

Few farmers had ever hired a tractor for land preparation, and those who had were mostly in Zone 3, where the land is flatter and the acreages larger than in the upper zones.

31. Farmers in Zone 1 seemed to be more flexible about being able to change their plans if the rains were late and farmers in Zone 3 less so. However the main ways in which the plans would be changed were: simply to wait for rain, planting later; or to change the proportions, planting more of crops which needed less rain. All possible ways of changing the plans which the farmers mentioned were considered to be risk-neutral, apart from delaying planting

until next season, which was considered very risk-averse, or planting a smaller acreage, which was considered to be fairly risk-averse.

For farmers who said they could not change their plans if the rains came late the main reasons were: that they already had the seeds or plants, so had no alternative; that they could not predict how much rain there would be or how the crops would be affected; or that they had already planted.

This question became a more hypothetical one in Zone 3, because by the time of interviewing there, the rains were already considered by the farmers to have begun.

Note: The answers to Question 32 of the questionnaire were not tabulated, but were used only to give valuable background information about farming in the area. This was also true for Question 11.

33 (a) For Zones 1 and 2, which were visited before the rains came, this question would be hypothetical unless the farmers were early planters and had already planted, but for Zone 3 the first rains had already come and the farmers had begun planting. There is of course a problem of defining exactly when the rains have begun.

The rains here referred to are the long rains of March/April. The farmers in the higher part of Zone 1 usually only planted potatoes and perhaps cabbages in these rains, planting the remaining crops such as maize and beans in the drizzling mists of July/August (which were counted with the short rains for the purposes of these tables). Therefore, farmers in Zone 1 who planted all the crops which they were going to plant in the long rains before the rains came, even if this was only potatoes, or potatoes and cabbages, were tabulated as being early planters.

'Part of the farm before, part after' means that the farmer might have planted a field of maize and beans before the rains and another field of the same crops after the rains. It therefore differs from alternative of 'some crops before; some crops after', which usually meant potatoes before the rain began, maize and beans after(or maize might also have been before).

No farmers in Zone 3 were early planters, and most planted all their crops after the first rains. This is largely because of the method of cultivation - they tended to plough and plant at the same time.

The most common times of planting, overall, were: all crops after the first rains; and: some crops before the rains had begun, some crops after.

(b) In the upper two zones, nearly all farmers prepared the ground before the rains but in Zone 3 a substantial proportion of farmers prepared it after.

(c) Half the farmers in Zone 1 prepared the ground entirely by hand-tools. In Zone 3 most farmers prepared the ground entirely by ox-plough. Most farmers in Zone 2 used an ox plough but many of them also prepared part by hand. Tractors were only used by a few farmers in Zone 3 and one farmer in Zone 2: in all cases these were hired.

(d) Each farmer gave a few crops in order of planting, usually only mentioning the most important crops. The usual order in all zones was potatoes, then maize followed by beans. For farmers who planted seasonal cash crops, it would have been interesting to observe whether they planted these before or after the foodcrops. Planting cash crops before food crops would be risk-taking, and planting the cash crops after the food crops were planted would be risk-averse. In practice, very few farmers planted seasonal cash crops. These farmers were all in Zone 3 and the information on their order of planting is incomplete, so could not be scored for risk.

The figures on the right of the mean rank and range show that in Zone 2 most farmers planted potatoes and maize before the rains began and beans after. In Zone 3 a few farmers planted potatoes before the rain began but maize and beans were nearly always planted after.

34. One third of the farmers in Zone 1, half the farmers in Zone 2 and most of the farmers in Zone 3 remembered November 1976 as having been dry. Others said that although it had not been entirely dry there had been too much sun. These conditions had spoilt the crops of the majority of farmers, especially in Zones 2 and 3, the main crops spoilt having been maize and beans.

35. Fencing was much more common in Zone 1 than in either of the other two zones, although for the farms in Zone 3 which were fenced, the areas fenced were much larger than in Zone 1.

Cattlesheds with a roof were not owned by many farmers but over half the farmers had an open-wood or bush boma.

Nearly all farms had at least one storehouse separate from the living house, the mean number per farm being highest in Zone 3, where the mean number of living houses was also highest. Only one farm in the sample had no living house on it, it was fairly near Kutus and the family lived in the village.

About half the farms had a separate kitchen, although sometimes one building fulfilled the purpose of store and kitchen so has been counted as a store above.

Over half the farms in each Zone had at least one corrugated iron roof on the buildings, the mean number of corrugated iron roofs being highest in Zone 3 and lowest in Zone 2. Otherwise the roofs were thatched.

A few farms especially in Zones 1 and 3 had a stone or wood bungalow with windows or a mud-brick and cement house with shutters. Most other dwellings were made of mud and/or wood, wood being more common in Zone 1 where there was more rain.

36. (a) Most of the farmers in Zone 1 had water pipes but almost half of them were not in use, either because of construction work or because the farmer had not paid his water bill. In such cases the farmer usually obtained water from a neighbour's pipe. For the farms without water pipes, water was usually carried by the women, or in a few cases, especially where the supply was far away, donkey or ox-cart was used. In Zones 1 and 2 there were many small rivers. Distances travelled to obtain water were difficult to assess, but usually they were under half a mile, or if further a donkey-cart was used.

37. Ox or donkey carts were owned by a higher proportion of farmers in Zone 3 than in either of the other two zones. This was true to an even greater extent for ox-ploughs. The highest proportion of farmers owning bicycles, however, was in Zone 2. Wheelbarrows were owned by about a third of farmers in Zones 1 and 3. Matatus and lorries were owned by very few farmers. No farmer in the sample had more than one ox-cart or plough. Two farmers in Zone 1 had two bicycles on the

farm and one farmer in each of Zones 1 and 3 had two wheelbarrows. One of the matatu-owners in Zone 1 shared it with one other person and one of the matatu owners in Zone 3 had 3 matatus as well as 3 lorries.

38. Out of watches, clocks, radios and sewing-machines, radios and watches were the most frequently possessed, radios being possessed by almost one half, and watches by almost one third, of farmers in the sample. Clocks and sewing machines were only possessed by a small proportion of farmers.

Two farmers in Zone 1 and one in Zone 3 had two watches on the farm, and one farmer in Zone 3 had 3 watches among his family living on the farm. Also three farmers in Zone 1 and one in Zone 3 had two radios.

39. The age given here refers to the head of the household i.e. the farm owner.

For the whole sample, and in Zones 1 and 3, the modal age group was 60-69. However the modal age group for Zone 2 was much younger, being 30-39 although there the second most frequent age group was 60-69.

The mean ages for Zones 1, 2, 3 and overall were approximately 55, 49, 56 and 53, so farmers in Zone 2 tended to be a little younger than in the other two Zones.

40. Only two farmers in the sample had been to secondary school. These were both in Zone 1. One was currently an auditor and the other a primary school headmaster and neither worked on the farm. In Zones 1 and 2 approximately two thirds of the farmers had been to school, while in Zone 3 the proportion was just over half. For Zone 1 the modal standard reached was Standard 3; for Zone 2, Standards 5 and 8 and for Zone 3, Standard 4.

The mean number of years of schooling for Zones 1, 2, 3 and overall were 3.1, 3.6, 2.7 and 3.2 so this did not vary much between the zones but was highest in Zone 2. Again the years of schooling refer to the head of the household, or farm owner.

41. (a) Almost half the farmers in Zone 1 and Zone 2 had attended armers Training Centres, but for the sample as a whole the proportion was one third, because of the small number who had attended in Zone 2. The mean number of weeks of courses attended was highest in Zone 1 (several farmers and wives had between them attended quite a few courses. Most of the courses were of either 1 or 2 week's duration).

(b) Other training included teacher training, nursing, apprenticeship for mechanics etc. Only training of either the husband or wife was counted - in most cases it was the husband who had been trained, although for farmers' training above, many wives had attended.

(c) The usual method of selection for courses at Farmers training centres was by an agricultural extension officer.

42. Here the terms 'skilled' and 'unskilled' have the same meaning as explained previously for question 4.

Zone 3 had the highest proportion of farmers with at least one family member in regular employment, and also the highest mean number regularly employed. This was true for both skilled and unskilled employment except that the mean number in unskilled employment was slightly higher in Zone 1. For the whole sample almost two thirds of farmers had at least one family member in regular employment, the numbers of skilled and unskilled workers being approximately equal.

Very few farmers mentioned family members in casual employment. This number could therefore have been underestimated because the emphasis in questioning was on regular jobs.

43. Few farmers had any other lucrative occupations apart from farming or paid jobs. The most common were owning or having a share in a duka or matatu and these happened most frequently in Zone 1 and Zone 3.

The information on sons owning a farm would be incomplete because this was volunteered, rather than being specifically asked for.

44. Not many farmers helped each other without pay, but this happened most frequently in the upper two zones. The kind of help given was usually coffee picking, weeding or harvesting.

45. (a) The mean numbers of family members: men, women and children here are obtained by dividing the total of each for each zone by the number of farmers in the zone, even though several farms had no men living there normally and a few had no women or children. The mean number of men did not vary much between the zones. The mean number of women was slightly higher in Zones 2 and 3 than in Zone 1, and the mean number of children was rather less in Zone 3 than in the other two zones.

About one quarter of all the farms had at least one male non-family member living there. This was usually a hired worker. The proportion did not vary substantially between the zones. Very few farms had other women or children living there.

(b) Almost every farm had women family members working on it every day. Therefore the mean number was obtained by dividing the total number of women by the number of farms in the zone. However a substantial proportion of farms did not have male family members working on them every day, so for men, the mean number was obtained by dividing the total by the number of farms which did. The proportion of farms having male family members regularly working there was three quarters in Zone 2, two thirds in Zone 3 and just over one half in Zone 1, although the mean number of male family members working per farm was slightly higher in Zone 1 than in either of the other two zones.

Not many farmers employed regular hired workers, but if so, they were usually men and were hired by a greater proportion of farmers in Zone 1 and zone 3 than in zone 2.

46. When oxen and a plough were hired two or sometimes three men came with the plough. In the long rains the highest proportion of farmers hiring a plough was in Zone 2. The mean number of man-days did not vary substantially between zones. No farmers in Zone 1 hired a team for ploughing and planting in the long rains. The proportion of farmers doing so was highest in Zone 3 but the mean number of man days was higher in Zone 2 although this was associated with a high range.

Fewer farmers hired the team for ploughing or ploughing and planting in the short rains than in the long rains. Tractors were only hired by a few farmers in Zone 3.

Apart from ploughing, almost half the farmers in Zone 1 and Zone 2 hired casual labour for coffee-picking. The mean number of man-days for coffee-picking is very approximate because the farmers thought in terms of the money they had paid the pickers rather than the number of people, who would be paid by the debe picked. Also they would not pick every day of the week. The main time for picking was between November and January.

Similarly for tea picking in Zone 1 the mean number of man-days per year is very approximate, since the workers might vary in number and would be paid by the amount picked. Tea picking takes place throughout the year but usually follows a pattern of for instance picking for two weeks, then not for one week and so on.

The mean number of man-days per year was easier to estimate for weeding, harvesting and ploughing than for coffee and tea picking, but they are still approximate and depend on the farmers' recall, since these questions referred to 1976. The mean number of man-days for harvesting was lower in Zone 2 than in either of the other zones. None of the sample farmers in Zone 3 hired labour for preparing the ground by hand.

47. Nursery School was most frequently attended by children from farms in Zones 1 and 2.

Over two thirds of farmers in all zones had children in day primary school, Standards 1-4, but the mean number of children did not vary between zones. Approximately half the farmers had children in day primary school Standards 5-7, the mean number of children being slightly less in Zone 1 than in other zones.

In summary, almost 85% of farmers in the sample had children at day primary school, the mean number of children there being almost three. Only two farmers, both in Zone 3, had children at boarding primary school.

48. Boarding Secondary School was more frequently attended than day secondary school. No farmer in the sample had children in Form 5 or 6. The proportion of farmers having at least one child in secondary school was highest in Zone 1 and Zone 3, but the overall proportion was only one third. The mean number of children in secondary school was highest for farmers in Zone 3.

49. Only a small proportion of farmers paid school fees for other relatives.

50. The major expenses apart from school fees and things for the farm were clothing, household expenses and food.

51. Almost two thirds of the farmers had a bank account but nearly all of them used it only to receive payments for sales of coffee, milk or tea, which they then cashed. The farmers who didn't know were cases in which the wife was interviewed.

52. By far the most important loaning agent was the Coffee Co-operative Society, which gave loans either of money or in kind, followed by KTDA which gave loans only of inputs for tea. Very few farmers admitted to having obtained loans from a bank, and no farmer mentioned A.F.C., which perhaps caters for better-off farmers than those in the sample.

The most frequent type of credit in-kind was fertilizer, followed by maize seeds, fungicide and insecticide. The proportion of farmers obtaining fertilizer was higher in Zone 1 than in the other zones, because there they could receive it from either the Coffee Co-operative or KTDA. The proportion of farmers in Zone 3 receiving loans both of materials and money was much lower than in other zones, mainly because most farmers in Zone 3 did not belong to the Coffee Co-operative Society as the climate there was unsuitable for coffee.

The mean amount of the loan of money was much higher in Zone 3 than in other zones, illustrating the fact that Zone 3 contained a few very wealthy farmers, most of whom made their money from business rather than farming.

53. The main activities taking place in Zone 1 at the time of interview (early March) were: tea picking, preparing the ground, weeding, spraying coffee and harvesting maize.

The main activities taking place in Zone 2 at the time of interview (mid March) were:

preparing the ground and removing rubbish, ploughing, planting and harvesting maize.

The main activities taking place in Zone 3 at the time of interview (late March) were: planting, ploughing, preparing the ground by hand and removing rubbish.

54. The worst problems mentioned were: Lack of money to hire labour, too much work, drought (especially in the lower two zones), lack of money, unavailability of labour (especially in Zone 1 for tea and coffee picking), lack of water (especially in Zone 2), poor soil, shortage of land, pests (especially in Zone 2), sickness.

55. The farmers worst fears were: drought causing poor harvest and famine (especially in Zones 2 and 3), lack of money to employ labour, too much rain (in Zone 1), too much work, infringement of boundaries by livestock in Zone 3, lack of money, crops being destroyed by pests or animals.

The data on income from ploughing came from asking a supplementary question, but this was not asked to all farmers who owned oxen. The practice was most common in Zone 3. The income from rent of rooms or shop was revealed during the course of the interview rather than being in answer to a particular question - again this information may be incomplete.

It is hoped that the foregoing tables and description have provided a useful summary picture of small-scale farming in Kabare Location.

CHAPTER FIVE

THE INDEX OF RISK AVERSION

A. A Theory of Risk in Agriculture

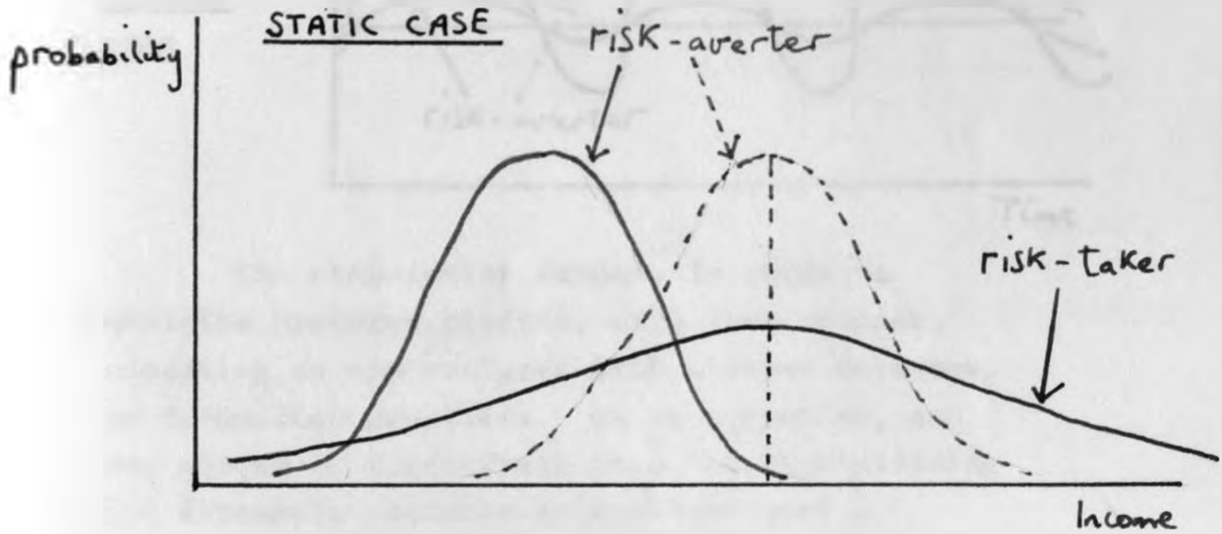
This section describes the premises upon which the derivation of the index of risk aversion is based.

The risk-averse farmer will be prepared to accept a lower mean income E(Y) coupled with a lower income variability σ_Y^2, than will a risk-taking or profit-maximising farmer. He will aim mainly to produce to satisfy the food requirements of his family and livestock, and if he can do that first, then to produce a little extra for cash. In contrast, a risk-taker would concentrate on maximising his cash income from the farm, specialising in cash crops, with only a small patch of food crops, and buying in food if necessary. The risk-averse farmer will tend to diversify his enterprises, especially among food and multi-purpose crops and livestock, so that at least some of his enterprises will succeed whatever the conditions. He is thus spreading the risks. He will also tend to mix crops so that even if one of the mixed crops fails, each part of his land will produce something. He will tend not to plant early, for fear of losing his seed.

The risk-averse farmer will also tend to grow a high proportion of crops which can resist too little, or too much, rain. He will tend to store most of his harvested food crops, at least until the next season's harvest is assured, rather than selling and later buying back as required, for fear that he will be unable to afford to buy when he needs food. He will be reluctant to contract a loan, for fear of being unable to repay and perhaps of having to forfeit part of his farm. He will tend to prefer crops and ways of farming of which he has experience rather than new crops and methods.

Neither risk aversion, nor profit maximisation, need necessarily be 'right' or 'rational' behaviour. This depends on the circumstances. 'Good' or 'progressive' farming practice is not simply related to risk. For example, Indian farmers were progressive to adopt high-yielding varieties, but were also risk-averse because these varieties were more stable (had less variability of yield). The same would apply to Katumani maize in Zone 3 of the area of the survey: progressive farmers would tend to grow it because it is relatively new variety and risk-averse farmers would tend to grow it because it is more stable. Neither need the risk-averse farmer necessarily be conservative. Conservative behaviour may show an element of risk aversion but not explicitly so. For example, the farmer who gives as a reason for mixing crops that he has never done otherwise is conservative and therefore somewhat risk-averse, but the farmer who mixes crops because then they will not all fail together, is purely risk-averse.

In summary, a risk-averse farmer may be defined as one who places a high value on producing his own food and who prefers a steady cash income which may be lower on average, to a more fluctuating one which may be higher on average; that is a lower mean income with lower variance will be preferred by the risk-averse farmer to a higher mean income with higher variance.* In simple diagramatic form:



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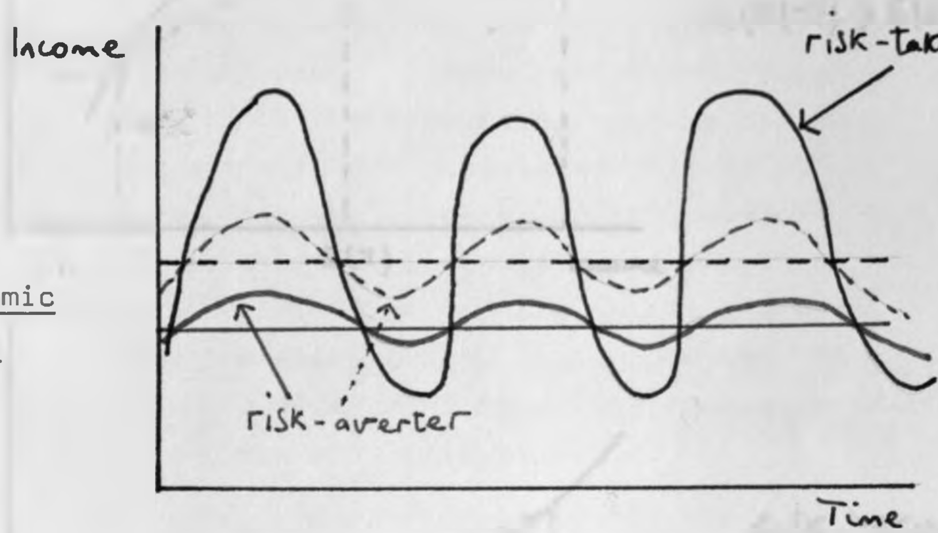
*The situation may arise where the risk-averter will not necessarily accept a lower income, but only less variability. This situation is depicted by the dotted lines in the diagrams for the static and dynamic case. However, most authors assume there is a trade-off: lower variability being associated with lower mean, and this practice has been followed here.

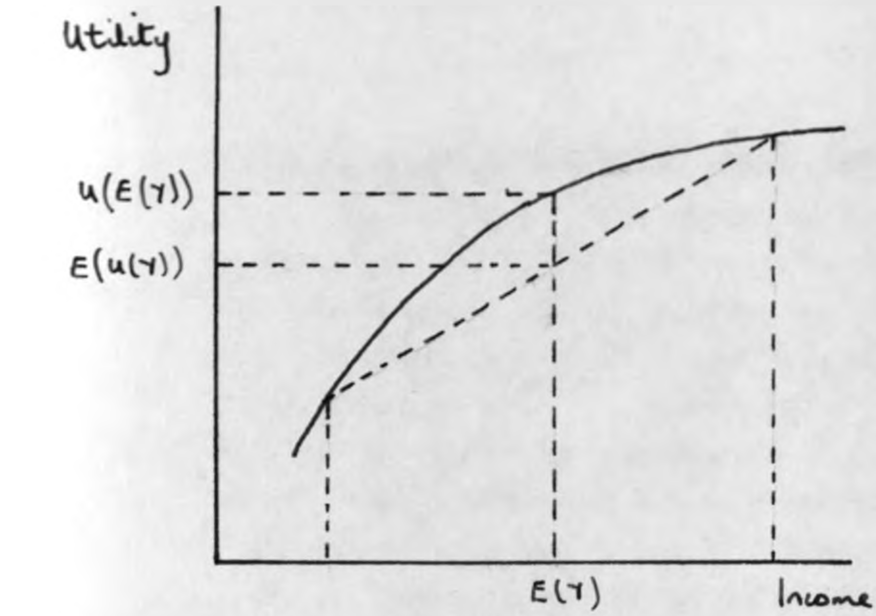
Although the income of the risk-taker can be much higher than that of the risk-averter, there exists a non-zero probability that it will be lower.

Dynamic case



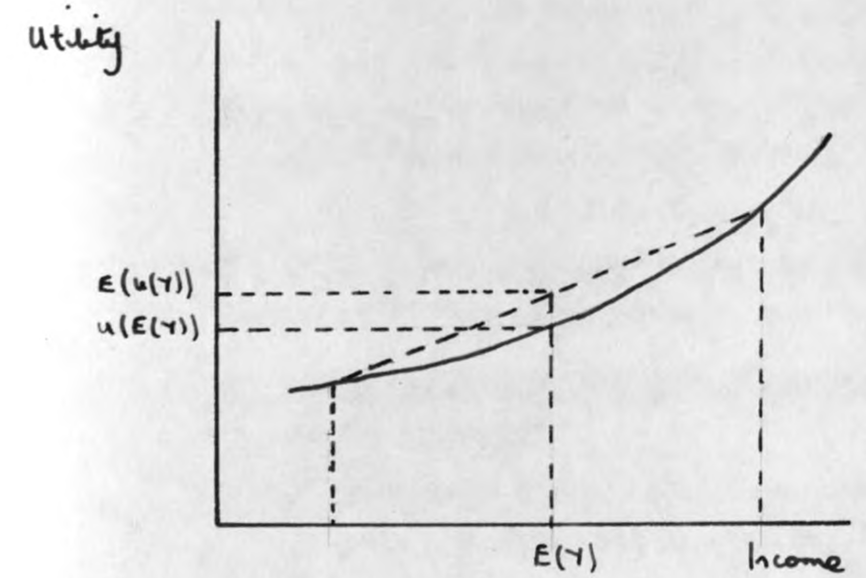
The risk-taking farmer, in order to maximise expected profits, will take chances, embarking on new ventures with unknown outcomes, or unfamiliar practices. He is a gambler, and may choose to concentrate on a few high-yielding but extremely variable enterprises with a substantial probability of loss.

Another diagramatic representation is in terms of utility (Friedman and Savage 1948). The risk-averse farmer wishes to maximise the expected utility of income, whereas the risk-taking farmer wishes to maximise the expected income. The utility function of the risk-averse farmer is therefore concave to the origin, while that of the risk-taking farmer is convex to the origin. For the farmer who is indifferent to risk, the utility function is linear.



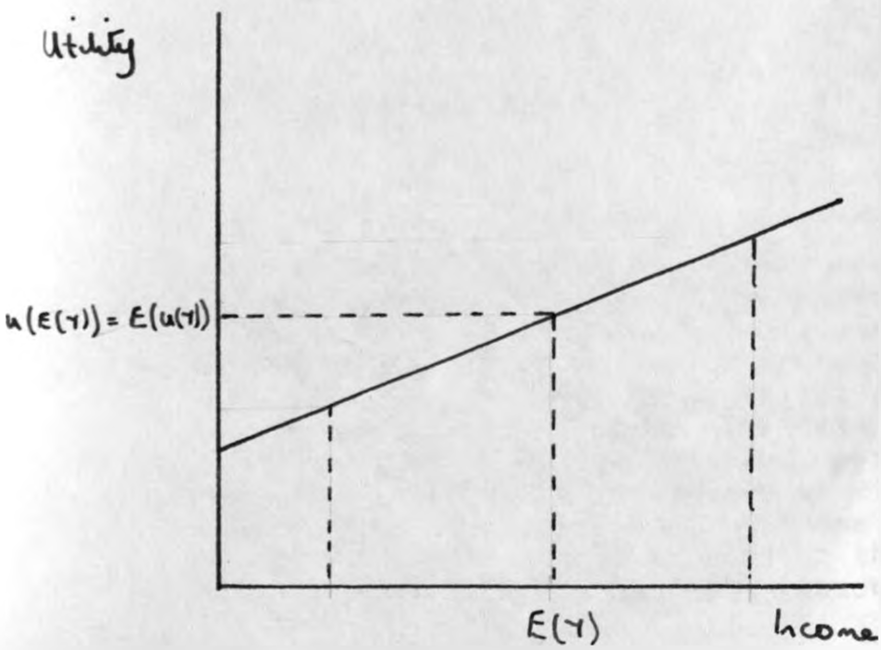
RISK-AVERSE

$u(E(Y)) > E(u(Y))$



RISK-TAKING

$E(u(Y)) > u(E(Y))$



INDIFFERENT TO RISK

$u(E(Y)) = E(u(Y))$

B. Derivation of the Index of Risk Aversion (IRA)

The index of risk aversion is a linear combination of 17 components. To test most of the hypotheses, all 17 components are included, but for testing a few of the hypotheses certain components of the index which are linked intimately with the hypothesis must be dropped. The 17 components are derived as follows. Positive scores are given for risk aversion (because more of the components measure risk aversion than risk taking) and negative scores are given for risk-taking. Each component is measured on a scale of 0 to 12 for risk aversion, 12 denoting the most risk averse.

0 to -12 for risk-taking, -12 denoting the most risk - taking. The choice of a 12 -point scale is arbitrary.

1) Reasons for mixing crops (question 12 on questionnaire)

- If one crop fails, the other might do well

Score: 12 for risk aversion if it is the sole reason given)*
6 " " " if it is one of 2 reasons)
4 " " " if it is one of 3 reasons)
3 " " " if it is one of of 4 reasons)

*Fewer points are given if the particular reason associated with risk aversion is one of several reasons than if it is the sole reason. The justification is that if it is the sole reason, it is considered to be of overriding importance in the farmer's decision-making, while its relative importance is assumed to diminish depending on how many other reasons it is associated with. This applies to the scoring of all components concerned with reasons.

- Have always mixed crops and never grown them separately.

  Score: 6 for risk aversion if it is the sole reason given.

  3 " " " one of 2 reasons not including the reason above.

  9 " " " if it is one of two reasons including the one above.

- To experiment and see what does best

  Score:-6 for risk taking if it is the sole reason given

  -3 " " " if it is one of 2 reasons not including the two above.

Other reasons for mixing crops as tabulated in the answers to question 12 are considered to be risk-neutral.

2) Reasons for growing cassava (question 14 on questionnaire)

- It resists drought so can be used for food if other crops fail.

  Score: 12 for risk aversion if it is the sole reason given.

  6 " " " if it is one of 2 reasons.

Other reasons for growing cassava as seen in the tabulated answers to question 14 on the questionnaire are considered to be risk-neutral.

3) Reasons for adopting a new crop or crops (question 16 on questionnaire)

- To experiment

Score: -12 for risk-taking if it is the sole reason given.

-6	"	"	"	one of 2 reasons
-4	"	"	"	one of 3 reaons
-3	"	"	"	one of 4 reasons

(Adopting a new crop is innovating behaviour but there is also a certain degree of risk involved)

Other reasons for adopting a new crop as tabulated in the answers to question 16 on the questionnaire are considered to be risk-neutral.

4) Diversification in types of maize grown (question 25)

- Growing 5 types (including different hybrids)
  Score: 12 for risk aversion
- Growing 4 types score: 9 for risk aversion
- Growing 3 types score: 6 for " "
- Growing 2 types score: 3 for " "

5) Changing plans of what crops and how much of each to plant if the rains are late (Question 31 on questionnaire)

- Not plant, but wait until next season
  Score: 12 for risk aversion if the sole strategy given.
  : 6 for risk aversion if one of two strategies given

- Plant a smaller acreage
  Score: 6 for risk aversion if the sole strategy given.
  3 for risk avers ion if one of two strategies given

Other ways of changing or not changing the plans if the rains were late, as tabulated in the answers to question 31, are considered to be risk-neutral; or else are captured in component (6) of the index (from question 33) which is concerned with time of planting.

6) Time of planting (Question 33 on questionnaire)

(Early planters are risk takers especially in dry areas. They risk losing the seed, but if it germinates they will get a better crop if they have planted before the rains)

- All crops planted before the rains
  Score: -12 for risk taking unless the farm is one of those in Zone 1 which has only one main cropping season, maize and beans being planted during the 'gathano' rains or drizzling mists of July/August. If such farmers are planting all the crops they plant in March/April, which are only potatoes and sometimes cabbages, before the rains, they score -4 for risk-taking.

- Part of the farm planted before the rains, part after (the same crops are partly planted before, partly after - see Chapter 4)
  Score: 12 for risk aversion (as the risks are spread)

- All crops planted after the rains
  Score: 6 for risk aversion

- Some crops planted before the rains, some after
  Score: 3 for risk aversion.

7) Having had a loan of money (question 52 on questionnaire)

Score: -12 for risk taking.

- Having had no loan even in kind if the farmer is a member of the coffee or cotton co-operative societies.

  Score: 12 for risk aversion.

- Fear getting a loan and being unable to repay (from answers to question 55)

  Score: 6 for risk aversion if they have had no loan of money.
  3 " " " if they have had a loan of money

8) Reasons for ceasing to grow certain crops (Question 17 on questionnaire)

- Climate unsuitable, or destroyed by pests or diseases.

  Score: 12 for risk aversion if sole reason
  6 " " " if one of 2 reasons

  (The farmers were averse to the risks involved so ceased growing these crops)

  Other reasons tabulated for ceasing to grow crops are considered to be risk-neutral.

9) Reasons for not producing more of certain foods on their own farm (Question 19(b) on questionnaire)

- Climate unsuitable or destroyed by pests or diseases.

  Score: 12 for risk aversion if sole reason
  6 " " " if one of 2 reasons

(The farmers were averse to the risks involved so did not grow more of those crops).

Other reasons tabulated for not producing more of certain foods are considered to be risk-neutral.

10) <u>New crops introduced in the last few years (Question 16 on questionnaire)</u>

Score: -12 for risk taking if 4 new crops introduced.

-9 for risk taking if 3 new crops introduced.

-6 for risk taking if 2 new crops introduced.

-3 for risk taking if 1 new crop introduced.

11) <u>Growing cassava (questions 9 and 10 on questionnaire)</u>

Score: 12 for risk aversion if at least 0.5 acre were grown.

9 for risk aversion if at least 0.25 acre were grown.

6 for risk aversion if some lines were grown.

3 for risk aversion if a few stems were grown.

(The total amount grown after long rains planting is considered)

12) <u>Growing sorghum</u>

Score: as above for cassava. (component (11))

Note (referring to component 13 on the following page).

One additional point arises in connection with component 13 relating to the proportion of food and multi-purpose crops grown. It had been hoped to classify each multi-purpose crop grown by each farmer into a proportion for food and a proportion for cash by examining the relative amounts of that crop which he sold and kept in the previous season. The reason was that maize, for example, is more important as a source of cash in lower than in upper zones, because in upper zones perennial cash crops can be grown. However this computation could not be done for some multi-purpose crops such as bananas, mangoes, sugar cane, tomatoes, cabbages because it was not possible to determine the amount consumed. Therefor the calculation was not done even for those crops such as maize, beans potatoes and pasture grass where the data were available. In any case, for multi-purpose crops the decisions of what proportions to sell are made *a posteriori* after having harvested, not *a priori* when planting. It was the *a priori* decision when planting which was being examined from the point of view of risk aversion.

13) <u>Mean proportion of food or multi-purpose crops grown</u>. Food or multi-purpose crops include every crop which is not a definite cash crop such as coffee, tea, sunflower, tobacco, cotton, black grams.

Thus food or multi-purpose crops are maize, beans, English potatoes, cabbages, tomatoes, bananas, sugar-cane, planted pasture - grass ,carrots, onions, green grams, yellow grams, wheat, sorghum, cassava, sweet potatoes, arrow root, yams, cowpeas.

The proportion of food or multi-purpose crops grown was calculated most easily by subtracting the proportion of cash crops grown from one. The divisor in this proportion was the acreage planted to seasonal crops and perennial crops, rather than the total acreage of the land holding. The divisor was thus the total acreage for which the family was responsible, minus fallow parts, so it included land hired from others and excluded land hired to others. Total acreage for which the family rather than the individual interviewed was responsible had to be taken, because perennial crops are usually considered to belong to the whole family living there, whereas maize and beans may be cultivated separately. The proportion was calculated separately for the short rains 1976 and long rains 1977 (including the fact that perennial crops may have been added) and the two proportions were averaged. In the few cases where no perennial crops were grown and the whole land area lay fallow during the short rains 1976, the proportion was indeterminate so only the proportion for long rains 1977 was taken. The higher the proportion of food and multi-purpose crops grown, the more risk averse is the farmer deemed to be. The proportion must therefore be multiplied by 12 so as to be comparable with the other components, before the weights are applied to derive the composite index.*

14) Mean proportion of seasonal crops mixed. The main crop mixture grown was maize/beans, but other mixtures which were grown by farmers in the sample were maize/tobacco, maize/cow peas, maize/beans/cowpeas, maize/black grams, maize/yellow grams, maize/sunflower, maize/coriander. The total acreage of mixed crops was divided by the total acreage of the farm planted to seasonal crops by all cultivators. This procedure was performed separately for the short rains planting of 1976 and the long rains planting of 1977. The two proportions were then averaged. In a few cases, where the farm was not planted in the short rains of 1976 in Zone 3 or Zone 2 the proportion was indeterminate for 1976, so only the long rains 1977 proportion could be taken. The higher the proportion of acreages of

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*In using this proportion as a measure of risk-aversion it is implicitly assumed that the farmer has a free choice as to whether he plants food or cash crops. The crops he may plant are ecologically determined. There may further be some official restrictions on increasing acreage of coffee. However, there will always be some cash crops which the farmer may add if he wishes to.

crop mixtures to acreage planted, the more risk averse is the farmer deemed to be. Again the proportions must each be multiplied by 12 to make this component comparable with the other components before the weights are applied to derive the composite index.

15) <u>Net **outflow** of staples in grain equivalents</u>

This figure was calculated as follows. For each staple: Maize, Beans and Potatoes, for the whole of 1976, the quantity amount sold + amount given away - amount bought (all amounts being in bags) was calculated. This gave the net outflow of each staple, which was sometimes positive, sometimes negative (where there was actually a net inflow). Using the approximate nutritional identity -

1 bag beans ≡ 2 bags maize ≡ 8 bags potatoes the net **outflows** were summed, for convenience in 'potato equivalents', which could be made into grain (maize) equivalents by dividing by 4.

If the net **outflow** is positive the farmer is risk averse, because he is producing more than enough to satisfy home demand.

If the net outflow is negative (a net inflow), the farmer is a risk-taker, because he is producing less than enough to satisfy home demand. The resulting net outflows were found to have a somewhat skew distribution.

Therefore the transformation

$$y = \log_{10}(1 + x) \qquad x \text{ +ve}$$

$$y = -\log_{10}(1-x) \qquad x \text{ -ve was made*}$$

where x is the net outflow in 'potato equivalents'. The largest absolute value of y was then 2.74 so in order to transform on to the 12 point scale, for comparability with the other components, the values must be multiplied by $\frac{12}{2.74} = 4.38$. This makes the absolute value of the largest negative number 7,02, and that of the largest positive number is 12.

16. Diversity of farm enterprises

Here it is assumed that the more a farmer diversifies his enterprises, the more risk averse he is. First the maximum number of crops grown in either season, no matter what amount, plus the number of different perennial crops and fruit trees was found. To this was added the number of livestock enterprises, which could be grade cattle, local cattle, sheep, goats, pigs, chickens. Donkeys were not counted as they are only used for pulling a cart, and very few farmers owned them. The maximum number of enterprises was found to be

*The transformations $y = \log(1+x)$ and $y = -\log(1-x)$ rather than $y = \log x$ and $y = -\log(-x)$ were made because sometimes x, the net outflow, was zero.

24, so by dividing by 2 this component was adjusted to the 12-point scale.

17) Food stored per person (question 21 of questionnaire)

To calculate this component the amounts of the staples: maize, beans, potatoes and sorghum given in the answers to question 21 were reduced to 'potato equivalents' for convenience, by using again the approximate nutritional identity 1 bag beans ≡ 2 bags maize ≡ 2 bags sorghum ≡ 8 bags potatoes. The total amount of such staples kept was then divided by the total number of people living on the farm, including both family members and hired workers, and counting children as ½ an adult. Children at boarding school, of course, were not counted. For two farms in Zone 3, no-one, and one person only, respectively, lived on the farm, the other family members living at Kutus village. For these farms the total number in the family was used as divisor rather than the number of people living on the farm, since it was supposed that the family members living at Kutus would be eating produce from the farm.

Another slight problem arose with divided farms. In such cases, the amounts which the farmer told us he kept or stored were invariably from the harvest of his own portion of the farm only, for consumption by his immediate family. Therefore in such cases the divisor was the number of people in his immediate family rather than the total number of people on the farm.

The demographic data obtained as answers to question 45 enabled this to be done with ease for 15 out of the 21 divided farms. It was particularly easy when the division of the farm was only to give 1 or 2 acres for the mother to cultivate. In only 6 cases, the number in the immediate family eating produce from that divided part of the farm belonging to the person interviewed had to be estimated from the numbers living on the farm as a whole.

It is assumed for this component that the more food stored per person, the more risk averse is the farmer, since he is unwilling to risk selling and then buying as required, because of shortages or price rises. The largest value for food stored per person was 40.8 potato bag equivalents so to reduce to the 12 point scale for comparability with the other components, all numbers must be multiplied by

$$\frac{12}{40.8} = 0.29$$

These 17 components can be classified into 3 groups.

(a) <u>Reasons for doing something on the farm</u> (5 of the components)

1. Reasons for mixing crops
2. Reasons for growing cassava
3. Reasons for adopting a new crop
8. Reasons for ceasing to grow certain crops
9. Reasons for not producing more of certain foods.

(where the left-hand numbers refer to the number of the particular component of the index of risk aversion)

(b) Factual information (10 of the components)

4. Diversification in types of maize grown
7. Having a loan
10. New crops introduced
11. Amount of cassava grown
12. Amount of sorghum grown
13. Mean proportion of food or multi-purpose crop grown
14. Mean proportion of seasonal crops mixed.
15. Net out-flow of staples.
16. Diversity of farm enterprises
17. Food stored per person.

(c) Hypothetical considerations (2 of the components)

5. Whether and how the plans of what crops and how much of each to plant would be changed if the rains were late.
6. Time of planting (some farmers were interviewed before, but some after, planting so for the latter farmers, this question would yield factual rather than hypothetical information).

To derive the composite index of risk-aversion each component had to be weighted. The weights were obtained by 3 criteria.

A. The degree to which the component measured risk (on a scale 1 to 10)

B. The reliability of the data on which the component was based (on a scale 1 to 10)

C. The accuracy of measurement
Criteria A and B were applied independently to each component, on two separate occasions. Each time the weights for criteria A and B were multiplied. The two estimations of the composite weight on both criteria for each component were then averaged. Briefly the kind of argument used is explained below for each component in turn.

1. A. The reasons, especially 'if one crop fails the other might do well' are considered to measure risk aversion well, and are therefore given a high weight.

   B. These reasons could be fairly well established during the interview.

2. A. the reason of drought resistance and therefore avoiding famine is considered to measure risk aversion well, and is therefore given a high weighting.

   B. This reason is not so well established in answer to the question "why do you grow cassava?" so is given a lower weighting than (1)

3. A. If the farmer's reason for adopting a new crop is to experiment, he is prepared to take a fair amount of risk.

   B. This reason is not very well established.

4. A. Diversification in types of maize grown is considered to be a good way of measuring risk aversion so is given a high weighting.

   B. The information which the farmer gave on this will tend to be reliable.

5. A. The ways in which the plans of what crops and how much of each to plant could be changed, if the rains were late, which are not risk-neutral, are considered to measure risk aversion fairly well so are given a fairly high weighting.

   B. These strategies are fairly hard to establish.

6. A. Whether planting is before or after the first rains should be expected to give a good idea of the farmer's attitude to risk.

   B. This information could be well established for those farmers who were interviewed after they had planted, but not so well for the others.

7. A. Having had a loan of money involves some degree of risk taking, but it is a fairly safe risk if the loan is through the Coffee Co-operative.

   B. Farmers may not have been truthful about whether they had had a loan and in cases where a wife was interviewed she sometimes did not know or could not tell.

8. A. A farmer who has ceased to grow certain crops because of unfavourable climate or pests or diseases is considered to have shown a fair amount of risk aversion.

   B. The actual reason for ceasing as with all reasons, is fairly hard to establish accurately.

9. A. A farmer who does not produce more of certain foods on his own farm because of unfavourable climate or pests or diseases is here supposed risk averse but perhaps to a slightly lesser extent than the farmer who has ceased to grow some crops for the same reasons.

   B. Again the true reason is quite hard to establish.

10. A. The more new crops a farmer introduces at the same time, the more risks he is taking. But his action in introducing new crops could also be following advice or copying others. Therefore this component is only given a moderate weighting.

    B. The new crops which a farmer has introduced recently only requires recent recall so can be well established.

11. A. The amount of cassava grown should be expected to give a fairly good indication of risk aversion. The proportion of the farm planted with cassava would have given a better indication, but as most farmers only

grew a small amount, it was not possible to calculate this proportion.

B. The farmers were usually able to give a rough idea of the amount of cassava grown.

12. A. Although sorghum is drought resistant, no farmer gave that fact as his reason for growing the crop, so the amount of sorghum grown is a fairly poor indicator of risk aversion.

B. The amount grown could be established roughly, as for cassava.

13. A. The mean proportion of food or multi-purpose crops grown could give only a limited indication of the farmer's risk aversion. It could to some extent also be determined by ecological factors. In Zone 3 perennial cash crops such as coffee and tea cannot be grown although there is more scope for seasonal cash crops such as sunflower and cotton than in the upper zones. Where the farmer could grow a greater acreage of cash crops but prefers to grow more multi-purpose or food crops, then he is being risk-averse because he is attempting to ensure an adequate food supply, even if some crops fail. He can vary the amount he sells according to his food requirements. This is not possible with cash crops.

B. The information on acreages although not very accurate for a particular crop, is reasonably good when taken overall. The proportion can therefore be estimated quite reliably.

14. A. The mean proportion of seasonal crops mixed is considered to measure risk aversion well since many farmers gave as a reason for mixing crops that they did not expect all crops to fail at once.

B. This proportion can be measured reliably as for (13) above.

15. A. The net outflow of staples is considered to measure risk-aversion fairly well. A risk-taking farmer might plant most of his farm with a cash crop and be prepared to buy in staples such as maize, beans, potatoes for food. On the other hand a risk-averse farmer might grow some cash crops but leave enough acreage on which to grow food crops that he expects not to have to buy any staples.

B. The amounts bought, given and sold should be remembered fairly accurately by the farmers. Using the approximate nutritional identity 1 bag beans ≡ 2 bags maize ≡ 8 bags potatoes, the net outflow is therefore measured reasonably well.

16. A. Diversity of farm enterprises is likely to be a good way of measuring risk aversion, since diversifying is usually held to spread the risks.

B. The data is reliable since farmers can be expected to know what enterprises they have, although equal weight is here given to enterprises of substantially differing importance so the measure is fairly crude.

17. A. Food stored per person should give a fairly good indication of the farmer's risk aversion because risk-averse farmers will tend to prefer to be self sufficient in food rather than being prepared to buy it.

B. The divisor, the number of people living on the farm, is fairly reliably obtained. The numerator, the amounts of staples stored, has more difficulties attached. For example, maize is often stored on the cob, whereas the farmer would try to estimate how many bags of shelled maize would be equivalent. Also, some farmers especially in Zone 2 harvest twice a year and amounts stored must be added, although some of the previous harvest might be sold when the new harvest came. Thus the reliability of the data is reduced, although some considerable effort was taken in explaining this question to each farmer.

On criterion B therefore all factual information is more reliable than either reasons given or hypothetical considerations. In addition a further distinction may be drawn. In obtaining the components, 8 are merely scored, (nos. 1, 2, 3, 5, 6, 7, 8, 9)

5 are counted (nos. 4, 10, 11, 12, 16) and

4 are measured (nos. 13, 14, 15, 17).

By criterion C, accuracy of measurement, those components which are merely scored are given single weight, those that are counted are given double weight and those that are measured are given triple weight. This reflects the amount of effort both interviewing in the field and later calculating which went in to deriving these components. It attempts to make the overall index a composite of equally reliable information.

The derivation of the weights is summarised in Table 5.1, and the values and distribution for the basic index of risk aversion IRA(A) are given in Table 5.2. Table 5.3 gives the mean and range for each component of IRA by Zone and overall, and table 5.4 summarises the different variants of the index of risk aversion by indicating which of the 17 components are omitted for each one.

The index of risk aversion may be summarised by the formula

$$IRA_i = \sum_{j=1}^{17} wj\ Cij$$

where IRAi is the value of the index for the i^{th} farmer (i = 1, ...,69)

wj is the final weight, obtained by Criteria A, B and C.

for the j^{th} component (j = 1, ...,17)

Cij is the value of the j^{th} component for the i^{th} farmer.

This formula applies to any of the ten variants

A,B,C,D,F,G,I,K,J,Z which are used in testing the hypotheses. The weights are the same for each variant, except that for each a different combination of weights is constrained to be zero.

Table 5.5 shows the values of each component of the index for each farmer in the three zones.

Table 5.1

Components

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1st Assessment																	
Criterion A	8	7	6	8	8	7	5	8	6	6	7	4	6	8	5	9	7
Criterion B	8	5	4	8	6	6	5	7	7	8	6	6	9	9	8	8	7
Product of weights	64	35	24	64	48	42	25	56	42	48	42	24	54	72	40	72	49
2nd Assessment																	
Criterion A	9	8	7	9	7	8	6	8	8	8	7	3	7	9	6	9	8
Criterion B	6	6	6	9	5	7	6	6	6	9	8	8	9	9	7	8	5
Product of weights	54	48	42	81	35	56	36	48	48	72	56	24	63	81	42	72	40
Mean product of weights÷100	0.59	0.415	0.33	0.725	0.415	0.49	0.305	0.52	0.45	0.60	0.49	0.24	0.585	0.765	0.41	0.72	0.445
Final weights after applying Criterion C	0.59	0.42	0.33	1.45	0.42	0.49	0.31	0.52	0.45	1.20	0.98	0.48	1.76	2.30	1.23	1.44	1.34

Note: The final weight assumes that all components have been reduced on to a scale ranging from -12 (most risk-taking) to +12 (most risk-averse)

Table 5.2

Basic Index of Risk Aversion IRA (A)

Farm No.	IRA(A)	Farm No.	IRA(A)	Farm No.	IRA(A)
1	58	24	90	49	75
2	46	25	63	50	68
3	40	26	21	51	96
4	11	27	48	52	93
5	60	28	70	53	80
6	30	30	76	54	51
7	57	31	75	55	92
8	27	32	50	56	104
9	54	33	39	57	65
10	37	34	66	58	56
11	56	35	82	59	72
12	58	36	91	60	58
13	35	37	69	61	68
14	39	38	83	62	76
15	62	39	51	63	80
16	50	40	59	64	74
17	42	41	54	65	100
18	48	42	25	66	67
19	30	43	54	67	71
20	76	44	87	68	49
21	47	45	48	69	65
22	20	46	79		
23	54	47	67		
29	36	48	62		
Zone 1		Zone 2		Zone 3	

The larger the value, the more risk-averse is the farmer.

The histogram below shows that the index of risk aversion has approximately the normal distribution. Therefore t-tests may be applied.

Class Interval	Frequency
10-19	1
20-29	4
30-39	7
40-49	8
50-59	15
60-69	12
70-79	10
80-89	5
90-99	5
100-109	2
	69

Histogram

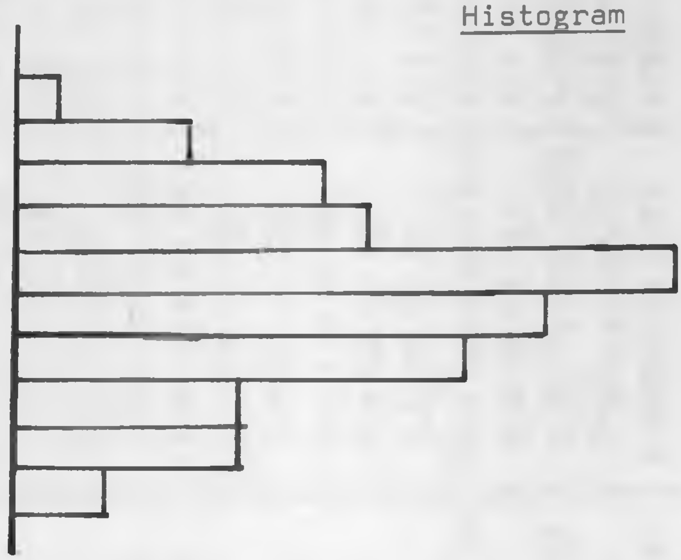

Table 5.3

Mean (and range) of components of index of risk aversion by Zone and overall

Component	Zone 1	Zone 2	Zone 3	Overall
1	3.1 (-3 to 12)	4.4 (-3 to 12)	5.0 (0 to 12)	4.1 (-3 to 12)
2	0 (-)	2.3 (0 to 12)	0.9 (0 to 12)	1.1 (0 to 12)
3	-1.3 (-6 to 0)	-1.9 (-12 to 0)	1.5 (-12 to 0)	-0.7 (-12 to 0)
4	0.9 (0 to 6)	3.3 (0 to 12)	4.9 (0 to 9)	3.0 (0 to 12)
5	1.6 (0 to 12)	0.3 (0 to 6)	0.3 (0 to 6)	0.8 (0 to 12)
6	2.4 (-12 to 12)	2.0 (-12 to 12)	5.9 (3 to 12)	3.3 (-12 to 12)
7	-5.3 (-12 to 12)	-3.8 (-12 to 12)	-2.9 (-12 to 12)	-4.1(-12 to 12)
8	4.5 (0 to 12)	1.8 (0 to 12)	1.7 (0 to 12)	2.7 (0 to 12)
9	3.3 (0 to 12)	5.8 (0 to 12)	8.9 (0 to 12)	5.9 (0 to 12)
10	-1.5 (-12 to 0)	-0.9 (-3 to 0)	-2.4 (-12 to 0)	-1.6 (-12 to 0)
11	1.4 (0 to 12)	4.4 (0 to 12)	5.1 (0 to 12)	3.6 (0 to 12)
12	0 (-)	3.9 (0 to 9)	3.4 (0 to 6)	2.4 (0 to 9)
13	7.7 (2.4 to 10.6)	10.0 (6.5 to 12.0)	10.5(6.0 to12.0)	9.4 (2.4 to 12.0)
14	3.4 (0 to 8.0)	5.4 (0 to 12)	6.5 (0 to 12)	5.0 (0 to 12)
15	2.4(-6.7 to 9.5)	1.5(-7.5 to 9.2)	4.5(-6.7 to 12.0)	2.7 (-7.5 to 12.0)
16	7.5 (4 to 10)	7-8(5 to 10.5)	7.5 (4 to 12)	7.6 (4 to 12)
17	2.6(0.1 to 11.8)	2.4(0.3 to 6.0)	2.9(0 to 9.9)	2.6 (0 to 11.8)

Table 5.4

Components omitted in different variants of the Index of Risk Aversion

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	IRA Variant
																	A
												X					B
					X												C
												X		X			D
						X											F
																X	G
X													X				I
		X							X								J
															X		K
	X					X				X	X	X		X			Z

Table 5.5 Values of the components of the Index of Risk Aversion for each farmer.

Zone 1.

Frmr. No.	Components 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	0	0	0	0	6	6	0	12	0	0	12	0	6.8	0	5.6	7.5	3.8
2	0	0	0	0	0	6	0	12	0	0	0	0	8.0	6.0	0	4.0	2.3
3	0	0	0	0	12	6	-12	0	0	0	0	0	6.0	6.0	0	6.5	1.8
4	0	0	0	0	0	-4	-12	0	0	0	0	0	2.4	2.5	-4.5	7.5	1.0
5	12	0	0	0	0	-4	0	0	12	-3	0	0	7.9	8.0	6.5	6.5	2.8
6	0	0	0	0	0	6	-12	0	0	0	0	0	7.2	2.0	0	8.0	1.7
7	12	0	0	3	0	-4	0	12	0	0	0	0	6.1	6.0	5.7	6.5	0.5
8	0	0	-6	0	0	6	0	0	0	-3	0	0	8.5	0	0	8.0	2.2
9	6	0	0	0	0	-4	0	0	0	0	3	0	6.5	6.0	7.6	8.5	2.1
10	12	0	0	0	0	-4	0	0	0	0	0	0	7.1	6.0	-4.2	6.5	0.8
11	9	0	0	6	0	3	0	0	0	0	0	0	6.6	6.0	4.9	4.5	1.9
12	6	0	0	3	0	-4	-12	0	12	0	0	0	6.4	4.3	9.0	8.0	5.2
13	0	0	0	0	0	6	12	0	0	-3	0	0	9.5	5.3	-6.0	7.5	0.1
14	0	0	-6	0	0	-12	-12	12	12	-3	3	0	10.6	0	5.9	8.5	1.5
15	12	0	0	0	0	6	-12	6	12	0	0	0	7.4	5.0	4.4	9.0	3.4
16	0	0	0	3	12	3	12	6	0	0	0	0	5.4	6.0	-5.2	9.5	1.3
17	0	0	-6	3	0	3	-12	0	0	-3	0	0	6.0	3.6	6.5	9.5	3.5
18	-3	0	0	0	0	12	-9	12	12	0	6	0	10.4	2.4	-6.7	7.5	2.0
19	0	0	-6	0	3	6	-9	12	0	-12	0	0	8.0	2.4	4.2	8.0	1.5
20	12	0	0	0	0	3	-12	12	12	0	3	0	10.2	2.4	5.7	7.0	11.8
21	0	0	-4	3	6	6	-12	6	0	-3	3	0	9.1	0	5.7	10.0	1.9
22	0	0	0	0	0	3	-12	6	0	0	0	0	7.9	0	-6.0	7.0	1.6
23	-3	0	0	0	0	6	0	0	0	0	0	0	10.1	1.8	9.5	8.5	5.6
29	0	0	-3	0	0	6	-12	0	6	-6	3	0	10.0	0	7.9	6.0	2.7

Zone 2

Frmr. No.	Component 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
24	0	0	0	6	0	6	-12	12	12	0	3	6	10.2	12.0	6.2	7.0	0.8
25	12	0	-6	3	0	3	-12	0	0	-3	0	6	10.6	6.0	7.0	6.5	4.3
26	0	0	0	0	0	-12	0	0	0	0	0	0	7.1	0	0	6.0	4.6
27	0	0	0	3	0	6	-12	0	0	0	3	6	9.7	0	6.5	8.0	1.6
28	0	0	0	0	0	3	-12	0	0	-3	6	9	10.4	10.9	6.6	8.0	1.8
30	6	0	0	3	0	3	0	0	6	0	6	9	9.2	2.9	9.2	10.0	4.0
31	12	0	0	6	0	3	0	0	12	0	6	6	9.7	7.2	-3.1	7.5	2.1
32	0	12	0	3	0	3	-12	0	12	0	6	6	10.4	0	-6.1	10.0	2.9
33	0	0	0	6	0	-12	-12	12	6	0	6	0	12.0	0	-4.4	5.0	1.5
34	12	0	0	3	0	3	0	6	12	0	0	0	6.5	11.8	-6.5	6.0	3.7
35	12	6	0	6	0	-12	-12	0	12	0	12	6	10.6	3.8	8.5	8.5	2.2
36	6	12	0	3	0	3	0	0	12	0	3	6	11.4	12.0	3.4	8.0	1.4
37	6	0	-4	6	0	3	0	0	12	-3	6	6	12.0	5.9	-6.6	10.0	4.1
38	12	12	0	3	0	12	0	0	6	0	12	6	10.6	8.3	-5.3	8.0	0.3
39	6	0	-12	0	0	3	0	0	0	-3	9	6	12.0	7.1	-7.5	9.0	0.8
40	0	0	0	6	6	3	0	0	0	0	6	6	9.5	0	3.9	7.5	3.9
41	0	0	0	3	0	3	-12	0	0	0	6	0	7.2	12.0	-4.4	6.0	1.8
42	-3	0	0	0	0	3	0	0	6	0	0	0	8.9	2.4	-6.0	5.5	0.7
43	0	0	0	0	0	6	12	0	0	0	3	0	8.4	1.6	4.6	8.5	6.0
44	12	0	0	0	0	6	0	0	12	0	3	3	9.7	12.0	6.6	9.0	1.2
45	0	0	-6	0	0	6	6	0	0	-3	0	0	10.7	2.6	7.5	7.0	3.7
46	6	0	0	12	0	-12	0	0	0	0	3	0	10.9	7.3	7.1	10.5	0.8
47	6	0	-12	3	0	12	0	12	6	-3	0	0	10.3	9.1	1.0	6.0	2.4
48	0	12	-6	3	0	6	-12	0	12	-3	6	6	12.0	0	6.8	9.5	1.2

Zone 3

Frmr. No	Components 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
49	12	0	-12	6	0	6	-12	0	12	-3	0	6	12.0	12.0	0	5.5	2.2
50	0	0	0	0	0	6	-12	0	0	-3	0	6	12.0	12.0	8.7	4.0	3.2
51	6	0	0	6	0	6	0	0	0	0	6	3	12.0	8.9	8.3	11.5	3.9
52	9	0	0	6	0	6	-12	0	12	0	9	0	11.8	6.8	8.4	10.0	3.3
53	12	0	0	6	0	6	-12	0	12	0	3	0	12.0	9.0	4.9	5.0	0.9
54	0	12	0	0	0	6	0	0	0	0	6	6	12.0	2.3	-2.5	6.5	0.8
55	0	0	0	6	0	3	0	0	12	0	12	0	12.0	4.2	10.9	6.5	8.3
56	12	0	0	6	0	6	12	12	12	-6	12	3	11.5	6.0	9.6	11.0	1.7
57	6	0	-3	9	0	3	12	12	12	-9	0	0	7.8	1.6	9.9	7.5	2.5
58	0	0	-4	6	0	6	0	0	12	-3	9	6	8.6	0.4	3.1	7.0	1.5
59	0	6	0	6	6	3	0	0	12	-3	9	6	10.7	4.8	-6.7	12.0	3.6
60	0	0	0	3	0	6	0	0	12	-3	0	6	8.5	12.0	-4.4	5.5	0.6
61	0	0	-4	6	0	6	0	0	0	-12	0	6	12.0	7.8	8.8	9.5	4.4
62	12	0	0	0	0	6	-12	0	12	0	0	0	11.3	4.4	12.0	8.0	5.8
63	6	0	0	0	0	6	0	0	12	0	6	0	12.0	12.0	4.2	4.5	1.3
64	0	0	-4	9	0	6	-12	0	0	-3	12	0	8.4	0	11.5	9.0	9.9
65	12	0	0	9	0	6	0	12	12	0	9	6	9.1	7.4	5.5	7.5	2.1
66	6	0	0	6	0	6	0	0	12	0	-3	6	10.1	8.9	-5.6	5.5	1.3
67	6	0	0	6	0	6	0	0	12	-3	0	6	10.2	4.6	7.2	8.5	1.5
68	6	0	0	3	0	6	0	0	6	0	0	0	6.0	12.0	-6.1	3.5	0
69	0	0	-4	3	0	12	-12	0	12	-3	12	6	9.7	0	7.5	9.0	3.0

CHAPTER SIX

STATEMENT OF HYPOTHESES

1. Farmers in higher zones take more risks than those in lower zones; or, the lower the zone, the more risk-averse is the farmer. i.e. if μ_1, μ_2, μ_3 are the mean values of the index of risk aversion (IRA) in Zone 1, Zone 2 and Zone 3 respectively for the whole of Kabare Location, $\mu_1 < \mu_2 < \mu_3$.

   The reason for this hypothesis is that the higher the zone, the more reliable is the rainfall, so risky enterprises have a greater chance of success. Argued the other way, the lower the zone, the less reliable is the rainfall so the more risk averse is the farmer. He cannot risk the possibility of famine.

   t-tests are carried out to test the null hypotheses $\mu_1 - \mu_2 = 0$ and $\mu_2 - \mu_3 = 0$ against the alternative hypotheses

   $$\mu_1 - \mu_2 < 0 \text{ and } \mu_2 - \mu_3 < 0$$

   The tests are thus 1-tailed (see statistical Appendix at the end of Chapter 6 for explanation of t-tests).

2. Farmers with large families living at home are more risk averse than those with small families living at home.

   The reason is because the farmer must meet certain food requirements. Therefore he cannot afford the possibility of increasing the likelihood of crop failure or famine.

Most farms (48 out of 69) were undivided so the size of the family living at home was unambiguous. For the 21 divided farms, only the number of immediate family members supported by the person interviewed was counted. Men and women were counted as one, children as a half. The number is the same as the divisor for component 17 of the index of risk aversion (food stored per person) except that hired workers and other non-family members living on the farm were excluded for the purpose of testing hypothesis 2. since they tend to be temporary and their presence or absence will not influence the decision-making of the farmer so much as that of immediate family members. To test this hypothesis IRA(G) which omits component 17 of the basic index of risk aversion IRA(A) is used so that figures relating to size of family do not enter into both the hypothesis and the data by which it is tested.

The hypothesis is tested by calculating the correlation coefficients between the index of risk aversion IRA (G) and the number in the immediate family, for each zone and for the sample as a whole. The correlation coefficients are expected to be positive and 1-tailed tests for their significance are carried out by using a Z-transformation. (See statistical appendix at the end of Chapter 6)

3. <u>Farmers with higher commitment for school fees take more risks than those with fewer children at school</u>. The reason is that they are willing to gamble for the cash prize of school fees.

Commitment for school fees was calculated from the answers to questions 47, 48 and 49 of the questionnaire, referring to numbers of children at Primary School and Secondary School, and any other relatives for whom School fees were paid. For divided farms it was not found to be possible to separate the numbers of school children belonging to each cultivator, so the total number of children at school for each farm was taken. Thus it was assumed that the head of the household was responsible for paying school fees for all school children of family members from the farm. Each farmer interviewed was only asked the numbers of children and not the cash amount paid in fees. Amounts vary especially for Secondary Schools, depending on whether they are Government or Harambee. Fees at Harambee Schools can be three times those at Government schools so it would have been better to distinguish between them in the questionnaire. The assumptions made about school fees derive from discussions with the Chief of Kabare, Mr. Jotham Nguri and some others and the results are rough estimates. The figures are annual and cost of uniforms is ignored. It was assumed that twice as many Secondary pupils attended Harambee as Government Schools.

Day Primary	Standard 1-4:Kshs 25)	per pupil
	Standard 5-7:Kshs 60)	+ shs 150 per parent (building fund)
Boarding Primary	Above and Kshs.850 boarding fee.	
Boarding Secondary Government	Kshs.700)	Boarding
" " Harambee	Kshs.1,600)	Secondary Kshs.1300
Day Secondary	K.shs.300	

This hypothesis is tested by obtaining the correlation coefficients between commitment for school fees and the basic index of risk aversion IRA(A) for each Zone and Overall. The coefficients are expected to be negative and therefore 1-tailed tests of significance are conducted.

4. Younger farmers take more risks than older farmers

It is generally supposed that young people tend to take more risks, older people tend to be more risk-averse.

The information obtained from question 39 of the questionnaire on ages of farmers was only their age class e.g. 40-49. Therefore each farmer was assigned the age approximately at the mid-point of his age class, in this example 45. This was done even in the few cases where the exact age was given. Correlation coefficients are calculated between IRA (A) and approximate age, for each zone and overall. The correlation coefficients are expected to be positive and 1-tailed tests for their significance are therefore conducted.

5(a) <u>Farmers with agricultural training (i.e. who have attended at least one course at a Farmers' Training Centre) take more risks</u>

Such farmers have a better understanding of how to cope with the consequences of risk-taking even if the resulting situation is adverse, since they have more knowledge to fall back on.

Farmers are designated as having had agricultural training if either the husband, or wife, or both, have attended at least one course at a Farmers' Training Centre. t-tests are made to test the null hypothesis

$\mu_F - \mu_{F1} = 0$ against the alternative

$\mu_F - \mu_{F1} < 0$ for each zone and overall,

where μ_F is the mean value of IRA(A) for farmers with agricultural training.

μ_F1 is the mean value of IRA(A) for farmers with no agricultural training.

The tests are thus <u>l-tailed</u>

5(b) <u>Farmers who have had some training (other than at School or Farmers Training Centres) take more risks than farmers with no such training</u>

The reason is that such farmers may have greater flexibility and greater confidence in their ability because of their training.

Farmers are designated as having had other training if either the husband, or wife, or both, have attended any training course or apprentice-ship.

t-tests are made to test the null hypothesis

$\mu_T - \mu_{T1} = 0$ against the alternative

$\mu_T - \mu_{T1} < 0$ for each zone, and overall

Where μ_T is the mean value of IRA(A) for farmers with other training.

μ_{T1} is the mean value of IRA(A) for farmers with no other training.

The tests are thus <u>1-tailed</u>

6. <u>Farmers with more years of schooling take more risks</u>

They are more aware of the possibilities open to them, have greater flexibility because of their education and greater confidence in their ability.

This hypothesis is tested by testing the significance of the correlation coefficients between the index of risk aversion IRA(A) and the number of years of schooling of the person responsible for running the farm, for each zone and overall. The correlation coefficients are expected to be negative and the tests are therefore <u>1-tailed</u>.

7. <u>Farmers who have been on that farm for a long time take more risks than more recent arrivals</u>

Farmers who have been on that farm for a long time are familiar with the conditions and can calculate the risks better. Also they have more resources to fall back on.

Conversely it could be argued that there are many risks involved in the early years of farming, whereas farmers who have been on that farm for a very long time may have developed a system of farming which they can rely on to bring them adequate food and cash income, and be averse to taking additional risks.

Since the case could be argued both ways, 2-tailed tests are made to see if there is a significant correlation between length of time on the farm and IRA (A), for each zone and overall, the null hypothesis being that the correlation coefficients are zero. (See statistical Appendix at the end of this Chapter for this and other tests of significance.)

8. Wealthier farmers take more risks

The reason is that wealthy farmers are staking less, and have more resources to fall back on, than less wealthy farmers.

It could be argued conversely that the wealthier farmer, having attained a certain status, becomes averse to risk-taking on his farm.

To test this hypothesis an estimate of wealth was computed for each farmer. For this purpose the following (new) values were used. Some of these derive from Kirinyaga District Guidelines 1976, District Agricultural Officer, Kirinyaga. They are all rough estimates. Numbers of each item possessed were obtained for each farmer from his answers to the questionnaire.

	Item	Approximate new value (K.shs)
1.	Local cow	1,000
2.	Local ox) Grade steer)	1,000
3.	Grade cow	2,500
4.	Goat	200
5.	Sheep	100
6.	Pig	200
7.	Donkey	500
8.	1 acre coffee) 1 acre tea)	2,000
9.	1 acre fenced	1,000
10.	1 mud or wood building	100
11.	1 corrugated iron roof	200
12.	1 piped water supply	400
13.	1 ox or donkey-cart	1,500
14.	1 ox-plough	800
15.	1 bicycle	700
16.	1 wheelbarrow	220
17.	1 matatu	40,000
18.	1 watch	200
19.	1 clock	100
20.	1 radio	300
21.	1 sewing machine	1,000
22.	1 duka	20,000

Thus the estimate includes both on-farm and off-farm wealth. As was expected the distribution of estimated wealth was positively skew, especially in Zone 3. Therefore a log transformation was applied to render the distribution more nearly normal.

The index of risk aversion used to test this hypothesis is IRA (B). This omits component 13 of IRA (A), the proportion of food and multi-purpose crops grown, since it is related to the acreage of cash crops - a component of wealth. 2-tailed tests are made for the significance of the correlation co-efficients between IRA (B) and $\log_e$ (estimated wealth), for each zone and overall.

9. Higher-income farmers take more risks

Higher-income farmers are staking less, and have more resources to fall back on, than lower-income farmers. They may only have attained a high income by taking risks on the farm. Alternatively, having attained a certain income and consequent status either from a job or from the farm, they may be averse to taking additional risks on the farm.

To test this hypothesis an estimate of annual income for 1976 was computed for each farmer. This included income from sale of crops and milk. (farm income) Amounts sold were given by the answers to question 20 of the questionnaire and these were multiplied by gross margins by crop (Source: Kirinyaga District Guidelines 1976 District Agricultural Officer, Kirinyaga). Non-farm income included net income from hire of land

and income from jobs of family members (only those living on the farm were included, except that when the head of the household did not live on the farm, his income was included.

The approximate figures which were used to calculate income are shown in the table below.

Gross Margins	K.shs
Coffee (kg)	0.60
Tea (kg)	0.50
Maize (bags)	40
Beans (bags)	120
Potatoes (bags)	8
Milk (bottles)	0.25
Bananas (whole bunches)	4
Cabbages (bags)	25
Mangoes (bags)	40
Oranges/Lemons (bags)	80
Tomatoes (kg)	0.7

Note: Income from hire of land: figures used were given by those farmers who hired.

Wages	K. shs. per month
Agricultural field worker	400
Mechanic	400
Driver	400
Turnboy	200
Auditor	2,000
Primary School headmaster	1,000
Primary School teacher	800
Coffee Factory supervisor	500

Wages (Kshs per month) Contd..

Nurse at dispensary	600
Barman	300
Cook	300
Clerk	600
Policeman	400
Shoemaker	400
Laboratory Technician	1,000
Labourer	300
Casual labour(tea nursery)	180
Casual farm work	150

Income (Kshs per month)

Matatu ownership	1,000
Duka "	800
Stone builder (self employed)	500
Painter (self employed)	500

The distribution of income was again found to be positively skew and so a log transformation was applied.

The index of risk aversion used here is IRA (D) which is IRA (A) omitting the components (13) proportion of food and multi-purpose crops grown and (15) net outflow of staples since both are related to amounts of crops sold.

2-tailed tests are made for the significance of the correlation coefficients between IRA(D) and loge (estimated income) - both loge (total income) and loge (farm income).

10. Farmers who own a vehicle (matatu, bicycle, ox or donkey-cart) take more risks than those without

Farmers with vehicles have greater mobility to transport supplies or produce, obtain help, advice etc.

1-tailed t-tests are used to test the null hypothesis $\mu_V - \mu_{V^1} = 0$ against the alternative for each zone and overall

$$\mu_V - \mu_{V^1} < 0$$

where μ_V is the mean value of IRA (A) for these farmers possessing a vehicle

μ_{V^1} is the mean value of IRA (A) for those farmers who do not possess a vehicle.

11. More 'progressive' farmers take more risks

To test this hypothesis an index of progressivity was calculated. It relates to farming practices and the weights are given below. The a priori weights reflect the degree to which the component measures the farmer's progressivity.

Component	Range	A priori weight	Adjusted weight = a priori weight / range
1. Number used out of: chemical fertiliser, manure, fungicide, insecticide, hybrid maize	0-5	6	1.2
2. Number of times per year which coffee is sprayed *	1-7	3	0.4
3. Proportion of the farm fenced	0-0.39	4	10
4. Early planting Score: (1 if all crops planted before the rains (0 otherwise	0-1	2	2
5. Farmers training. Score: (1 if FTC attended (0 otherwise	0-1	2	2
6. Proportion of cattle which are Grade	0-1	5	5
7. Written records kept. Score: (1 if so (0 if not	0-1	2	2

*Farmers who did not have coffee were compensated by being given the overall mean of 3.8 times/year for the farmers who did have coffee.

Higher values of this index therefore reflect greater progressivity on the part of the farmer.

To test the hypothesis IRA (C) is used. This omits component (6) of IRA(A), which relates to time of planting.

Coefficients of correlation are computed between IRA(C) and index of progressivity for each zone and overall. 1-tailed tests of their significance are made since the correlation coefficients are expected to be negative.

12. <u>Farmers who are near to the road take more risks</u>

It is easier for such farmers to obtain transport so they can obtain supplies quickly, market excess produce etc.

Farms were roughly classified as being near to or far from the road according as their farm was less than or further than approximately 0.5 km from the road. The road could be earth murram tarmac or stone but was recognisably passable to motor vehicles and not a footpath or land adjudication boundary.

1-tailed t-tests are carried out to test the null hypothesis.

$\mu_N - \mu_{N^1} = 0$ against the alternative

$\mu_N - \mu_{N^1} < 0$ for each zone and overall where $\bar{\mu}_N$ is the mean value of IRA(A) for farms beside the road.

$\bar{\mu}_N 1$ is the mean value of IRA(A) for farms over 0.5 km from the road.

13. <u>On farms which are divided, fewer risks are taken</u>

The reason is because each cultivator is aiming mainly to produce enough food for himself and his family on his small plot so is averse to risk-taking.

1-tailed t-tests are used to test the null hypothesis $\bar{\mu}_D - \bar{\mu}_D 1 = 0$ against the alternative for

$$\bar{\mu}_D - \bar{\mu}_D 1 > 0$$

each zone and overall.

where $\bar{\mu}_D$ is the mean value of IRA(A) for divided farms

$\bar{\mu}_D 1$ is the mean value of IRA (A) for undivided farms,

divided farms being those where food crops are cultivated separately by different individuals.

14. <u>Farmers who hire additional land on another farm take more risks than those who do not</u>.

Such farmers are willing to outlay cash to hire the land and to risk planting on it. In so doing, they are exchanging steady payments for a fluctuating return. Conversely, it could be argued that these farmers are diversifying by cultivating in two places of differing soil and perhaps differing rainfall conditions (if the hired part is an appreciable distance from their own farm) and so are risk-averse.

Therefore 2-tailed t-tests are made of the null hypothesis.

$\mu_H - \mu_H 1 = 0$ against the alternative

$\mu_H - \bar{\mu}_H 1 \neq 0$ for each zone and overall.

where $\bar{\mu}_H$ is the mean value of IRA(A) for farms where an additional few acres are hired $\bar{\mu}_H 1$ is the mean value of IRA(A) for farms where no extra part is hired from others.

15. <u>Farmers who hire out part of their farm are more risk-averse, than those who do not</u>

Such farmers have exchanged a fluctuating income from cultivating the hired land for a steady one from payments for hire. Moreover they now have less land remaining on which to grow food, so they wish to reduce the chances of crop failure.

Conversely it would be argued that in giving up some cultivatable land in exchange for money, the farmers risk **missing** a higher return from the land in a good season.

2-tailed t-tests are made of the null hypothesis

$\bar{\mu}_h - \bar{\mu}_h 1 = 0$ against the alternative

$\bar{\mu}_h - \bar{\mu}_h 1 \quad 0$ for each zone and overall.

where $\bar{\mu}_h$ is the mean value of IRA (A) for farmers who have hired out part of their farm.

μ_h' is the mean value of IRA(A) for farmers who have not hired out any of their farm.

16. <u>Farmers who have relatives living near take more risks than those who do not</u>

The reason is that they are not isolated and can rely on help in times of need. Conversely, they may be more risk averse because they cannot chance crop failures if they have to support relatives also - they have a greater food requirement as in hypothesis. 2. Moreover there may be a social pressure not to innovate. 2-tailed t-tests are made of the null hypothesis.

$\mu_R - \mu_R 1 = 0$ against the alternative

$\bar{\mu}_R - \bar{\mu}_R 1 \neq 0$ where

$\bar{\mu}_R$ is the mean value of the index of risk aversion IRA (A) for farmers who have relatives living quite near to their farm.

$\bar{\mu}_R 1$ is the mean value of IRA(A) for farmers who do not have relatives living near.

The farmer's own definition of 'quite near' was taken in answer to question 3(c) of the questionnaire. It would approximate to 'within the same location'.

17. <u>Farmers who have a greater acreage take more risks than those owning only a small plot</u>

The argument, as for the wealth and income hypotheses 9 and 10, is that farmers with larger acreages have more resources to fall back on.

They are staking less when they grow a risky crop on a few acres of their farm. On the other hand, farmers with large acreages often leave large proportions of their farm fallow and this may be risk-averse.

To test this hypothesis correlation coefficients are computed between IRA(A) and acreage for each zone and overall. The definition of acreage used was the area for which the family living there was responsible.

= total acreage owned
+ acreage hired from others
- acreage hired to others.

where the acreage varied between the short rains and the long rains because of different hiring practices, the mean acreage was taken.

2-sided tests are conducted for the significance of the correlation coefficients.

18. <u>Farmers who have a full-time job away from the farm take more risks than those who do not</u>. Farmers who have other full-time jobs, which yield a steady income, may be prepared to take risks on the farm because they have the steady income to fall back on. On the other hand, having received a steady income from their job they may not wish to gamble for additional cash return from the farm. Moreover they may neglect the farm especially if they do not live there, or the person left responsible may be more risk-averse than the owner would have been.

Only full-time jobs of the owner of the farm were counted for testing this hypothesis.

2-tailed t-tests are carried out to test the null hypothesis

$\mu_J - \mu_J 1 = 0$ against the alternative.

$\mu_J - \mu_J 1 \neq 0$ for each zone, and overall.

where $\bar{\mu}_J$ is the mean value of IRA(A) for farmers who have a full-time job

$\mu_J 1$ is the mean value of IRa(A) for farmers who do not have a full-time job.

19. Farmers with a smaller work-force are more risk-averse. They have a smaller pool of labour to call on, so are constrained from undertaking risky activities which are governed by timeliness of farm operations.

The work-force was defined here to be the number of adult family members who were usually working on the farm every day plus any regular adult employees (casual employees were not included).

This hypothesis does not conflict with Hypothesis 2 since the size of family living at home (which includes children,and does not include hired workers) need not bear any relationship to the size of the work force, as adult: child ratios vary considerably.

This hypothesis is tested by examining the significance of the correlation coefficients between the index of risk aversion IRA(A) and the size of work force for each zone and overall.

These correlation coefficients are expected to be negative and the tests are therefore 1-tailed.

In addition to the above hypotheses, some particularly interesting components of the index of risk aversion IRA(A) are tested for their correlation with the rest of the index. These form six additional hypotheses, as well as providing checks of internal consistency of the index of risk aversion.

20. Farmers who mix a high proportion of their crops are more risk averse than those who grow a high proportion of pure stand.

A prevalent reason for mixing crops is that not all crops are expected to fail at once. This is risk aversion by the farmer.

To test this hypothesis IRA(I) is used. This is IRA(A) omitting two components:

(14) the mean proportion of seasonal crops mixed in the short rains and the long rains.

(1) reasons for mixing crops

Correlation coefficients are then calculated between IRA(I) and component (14) of IRA(A) for each zone and overall. The correlation coefficients are expected to be positive and 1-tailed tests of their significance are carried out.

21. Farmers who have a high number of enterprises are risk-averse. They are diversifying, so spreading the risks, instead of concentraing on a few enterprises which might fail.

To test this hypothesis, index of risk aversion IRA(K) is used. This omits component (16) which relates to number of enterprises (livestock and crop). Correlation coefficients between IRA (K) and this component (16) are calculated for each zone and overall. They are expected to be positive and 1-tailed tests for their significance are carried out.

22. Farmers who have recently introduced new crops are risk-takers. By innovating they are taking a certain risk. The reverse argument could also be propounded: by introducing new crops the farmer is increasing the total number of enterprises and therefore diversifying and averting risk.

To test the hypothesis, index of risk aversion IRA(J) is used. This is IRA(A) with 2 components omitted:

(10) relating to number of new crops introduced, and

(3) reasons for introducing new crops.

2-tailed t-tests are used to test the null hypothesis.

$\bar{\mu}_I - \bar{\mu}_{I^1} = 0$ against the alternative

$\bar{\mu}_I - \bar{\mu}_{I^1} \neq 0$ for each zone and overall, where

$\bar{\mu}_I$ is the mean value of IRA(J) for those farmers who have recently introduced one or more new crops (in the last few years).

μ_I1 is the mean value of IRA(J) for those farmers who have introduced no new crops in the last few years.

23. <u>Farmers who grow a higher proportion of food and multi-purpose crops are more risk averse than those who grow a lower proportion</u>

Such farmers are leaving open the options of whether to sell or consume until they see how the crops succeed. Farmers with a lower proportion of food and multi-purpose crops and therefore a higher proportion of cash crops risk having to buy food and risk a greater loss if their cash crops fail although a greater pay-off will result if they succeed.

To test this hypothesis, IRA(B) is used. This omits component (13) (proportion of food and multi-purpose crops) of IRA(A).

Correlation coefficients between IRA(B) and component (13) are calculated for each zone and overall. They are expected to be positive and 1-tailed tests of their significance are made.

24. <u>Farmers who plant early are risk-takers.</u>

They risk loosing their seed if rain comes late but they are gambling for an increased harvest if their strategy pays off. Farmers who plant all or part of their farm after the rains are risk averse - they are unlikely to loose their seed but will probably not get the maximum possible harvest. Of course some crops such as potatoes are more **amenable** to early planting than others such as beans.

To test this hypothesis, IRA(C) is used. This omits component (13), which relates to time of planting, from the index of risk aversion.

The answers to question 33(a) on the questionnaire, on time of planting, fell into 4 groupings.

(i) Early planters, who planted all their crops before the first rains. These can include those farmers in Zone 1 who planted most crops once a year in July/ August but had planted all the crops which could be planted in March/April (mainly potatoes and cabbages) before the rains came. There were no early planters in Zone 3 mainly because there, most farmers used ox-plough to prepare the ground, after the first rains had come, and planted at the same time as ploughing.

(ii) Late planters, who planted all their crops after the first rains.

(iii) Farmers who planted some crops (e.g. potatoes) before the rains and other crops (e.g. maize and beans) after.

(iv) Farmers who planted part of their farm (including maize and beans) before the rains and the rest of their farm after.

For the purpose of calculating component (6) of IRA, group (i) were deemed risk-takers and the other groups risk averse, increasingly so in the order (iii), (ii), (iv).

To test the hypothesis, 1-tailed t-tests are used to test the null hypothesis.

$\mu_E - \mu_E1 = 0$ against the alternative

$\mu_E - \mu_E1 < 0$ zone and overall,

where μ_E is the mean value of IRA(C) for early planters (Group (i)above)

μ_E1 is the mean value of IRA(C) for late planters (Group(ii) above)

25. <u>Farmers who have had a loan of money take more risks than those who have not</u>

The act of having a loan involves a risk although this is truer of loans from a bank or the A.F.C. than from the Coffee Co-operative Society. Most loans obtained by farmers in the sample were of the latter type.

It could be argued that commitment to repay a loan requires a steady rather than fluctuating income, so the farmer who has had a loan is more risk-averse than one who has not.

To test this hypothesis, the index of risk aversion IRA(F) is used. This omits component (7) which relates to having had a loan.

2-tailed t-tests of the null hypothesis

$\mu_L - \mu_L 1 = 0$ against the alternative

$\mu_L - \mu_L 1 \neq 0$ are applied for each zone and overall.

where μ_L is the mean value of IRA(F) for those farmers who have had a loan of money.

$\mu_L 1$ is the mean value of IRA(F) for those farmers who have not had any loan of money

Finally, one hypothesis will be tested which stems from the literature reviewed, and does not concern the index of risk aversion.

26. <u>Farmers with smaller holdings often plant larger proportions of their land with cash crops than slightly larger farmers</u>

Kunreuther (1974) states that this hypothesis has been supported by several empirical studies. This would seem to indicate that the farmer focuses on short-run goals such as minimum income in planning his crop allocation. However, if crop-planting decisions at the beginning of a particular season were based on avoiding risk, it might be expected that farmers with smaller holdings would plant <u>smaller</u> proportions of their land with cash crops.

Therefore 2-sided tests for the significance of the correlation coefficients between acreage for which the family is responsible and proportion of cash crops are conducted, for each zone and overall.

Statistical Appendix.

A. Testing the significance of the difference in means.

For all the hypotheses for which this test is employed, the null-hypothesis takes the form

$\mu_A - \mu_{A'} = 0$ against either of the one-sided alternatives

$\mu_A - \mu_{A'} < 0$ or $\mu_A - \mu_{A'} > 0$

or else the two-sided alternative

$\mu_A - \mu_{A'} \neq 0$ where

μ_A is the mean value of the index of risk aversion for members of the population having attribute A

$\mu_{A'}$ is the mean value of the index of risk aversion for members of the population not having attribute A.

The difference in sample means $\bar{X}_A - \bar{X}_{A'}$ is the best estimate of $\mu_A - \mu_{A'}$ and the samples will have unequal sizes, as is common in comparisons made from survey data.

It is assumed that the variance is the same in both populations. This is a reasonable assumption in nearly all cases here considered, since F testing would generally not support a hypothesis of any significant differences in variance.

With samples of sizes n_A, $n_{A'}$, their means $\bar{X}_A$ and $\bar{X}_{A'}$ have variances $\frac{\sigma^2}{n_A}$ and $\frac{\sigma^2}{n_{A'}}$, where σ^2 is the variance for the overall population. The variance of the difference is then

$$\frac{\sigma^2}{n_A} + \frac{\sigma^2}{n_{A'}} = \sigma^2 \left[\frac{1}{n_A} + \frac{1}{n_{A'}} \right] = \sigma^2 \left[\frac{n_A + n_{A'}}{n_A \, n_{A'}} \right].$$

Each sample furnishes an estimate of σ^2, call these estimates s_A^2 and $s_{A'}^2$.

where $s_A^2 = \frac{\sum x_A^2}{n_A - 1}$ and $s_{A'}^2 = \frac{\sum x_{A'}^2}{n_{A'} - 1}$

and $x_A = X_A - \bar{X}_A$, $x_{A'} = X_{A'} - \bar{X}_{A'}$

pooled estimate of variance

$$s^2 = \frac{(n_A - 1)\, s_A^2 + (n_{A'} - 1)\, s_{A'}^2}{n_A + n_{A'} - 2}$$

$$= \frac{\sum x_A^2 + \sum x_{A'}^2}{n_A + N - 2}$$ with $n_A + n_{A'} - 2$ degrees of freedom.

For the best estimate of the variance of the difference, o^2 is replaced by s^2 in * , yielding

$$\left[\frac{(n_A - 1)\, s_A^2 + (n_{A'} - 1)\, s_{A'}^2}{n_A + n_{A'} - 2}\right] \left[\frac{n_A + n_{A'}}{n_A\, n_{A'}}\right]$$

Then $$t = \frac{(\bar{X}_A - \bar{X}_{A'})\sqrt{n_A\, n_{A'}}}{s\sqrt{n_A + n_{A'}}}$$

follows Students t - distribution with $n_A + n_{A'} -2$ degrees of freedom.

In these tests, since there is no reason to suppose non- homogeneity of variance for the sample as a whole, the pooled estimate of variance used is the same for each intra-zonal and overall comparison and came from six groups, with and without the attribute in each zone. This gives a better estimate of variance as it is based on more degrees of freedom than that for a single zone, and for the overall comparisons, inter-zonal sources of variation have been removed, making the test more powerful.

Reference: Snedecor, G.W. and Cochran, W.G. Statistical Methods. Sixth edition 1967 pages 100-105

B. <u>Testing the significance of the correlation coefficient.</u>

For all the hypotheses for which this test is employed, the null hypothesis is $\rho = 0$ where ρ is the population correlation coefficient.

For a two-sided test of significance of the correlation coefficient, the alternative hypothesis is $\rho \neq 0$

For a one-sided test, where the correlation coefficient is expected <u>a priori</u> to have a negative sign, the alternative hypothesis is $\rho < 0$

For a one-sided test where the correlation coefficient is expected <u>a priori</u> to have a positive sign, the alternative hypothesis is $\rho > 0$

Two-sided tests are made directly from a table (Snedecor and Cochran p. 557 Table A11).

One-sided tests are conducted using the z-transformation, a standard procedure due to Fisher, for testing hypotheses about ρ. It requires the assumption that the (X,Y) pairs are a random sample from a bivariate normal distribution, whereas to test $\rho = 0$ using r, one variate need not be normally distributed provided that the other is. This is reasonable for most of the data in this study, since very skew distributions have been log-transformed.

If r is the sample correlation coefficient let

$$z = \tfrac{1}{2}\left[\log_e(1 + r) - \log_e(1 - r)\right]$$

Then z is distributed almost normally with standard error

$$\sigma_z = \frac{1}{\sqrt{n - 3}}$$

and mean $\zeta = \tfrac{1}{2}\left[\log_e(1 + \rho) - \log_e(1 - \rho)\right]$

Under the null hypothesis $\rho = 0$ so $\zeta = 0$

Tables enable the transformation from r to z and z to r to made easily (Snedecor and Cochran pages 558 and 559).

From these and normal tables the critical absolute values of r necessary for significance can be computed.

<u>Zone 1 or Zone 2</u>

n - 3 = 21

Significance level	Critical absolute value of r for one-sided test
10%	0.273
5%	0.345
1%	0.470

<u>Zone 3</u>

n - 3 = 18

10%	0.291
5%	0.371
1%	0.500

<u>Overall</u>

n - 3 = 66

5%	0.197
1%	0.282

<u>Reference</u> Snedecor, G.W. and Cochran, W.G. <u>Statistical Methods</u> Sixth edition 1967 pages 184-185

CHAPTER SEVEN

RESULTS.

1. Farmers in higher zones take more risks than those in lower zones.

Let X = index of risk aversion IRA(A)

	Zone 1	Zone 2	Zone 3	Overall
n	24	24	21	69
$\bar{X}$	44.7	62.9	74.3	60.0
Var(X)	224	359	243	417
Difference in means	18.2	11.4		

Pooled Var(X) = 277 (66 d.f.)

S.E.D. 1,2 = 4.8 t = 3.79**
S.E.D 2,3, = 5.0 t = 2.28*

The 1-tailed t tests show that $\mu_1 < \mu_2$ at the 1% level of significance and $\mu_2 < \mu_3$ at the 5% leve of significance. where μ_1 , μ_2 and μ_3 are the mean values of the index of risk aversion IRA(A) in zones 1, 2 and 3 respectively. The hypothesis is thus confirmed: the mean value of the index of risk aversion IRA(A) increases as one moves to a lower zone. To investigate this result, another index of risk aversion IRA(Z) is calculated by omitting components of the basic index IRA(A) which were biased by ecology. The following components are omitted:

Component 2: Reasons for growing cassava (because less cassava was grown in zone 1 than in the lower zones).

Component 11: Amount of cassava grown (for the same reason)

Component 12: Amount of sorghum grown (because sorghum was grown less in Zone 1 than in the lower zones)

Component 7: Having a loan (because it was fairly easy for the farmers in Zones 1 and 2 who grew coffee to obtain a loan from Kabare Coffee Co-operative Society. This was not so for the farmers in Zone 3 who did not have coffee).

Component 13: The mean proportion of food and multi purpose crops grown (because in the lower zones there were fewer cash crops so this proportion was higher)

Component 15: Net outflow of staples (This tended to be higher in the lower zones where staples were sold in lieu of cash crops).

IRA(Z) tends to measure risk aversion less well than IRA (A) because it is based on 11 rather than 17 components. However it should certainly be freer of ecological biases.

Testing hypothesis 1 for IRA(Z) gave the following results.

Let X^1 = index of risk aversion IRA(Z)

	Zone 1	Zone 2	Zone 3	Overall
n	24	24	21	69
$\bar{X}'$	27.9	37.6	44.4	36.3
Var(X')	113	238	138	205

Difference in means 9.7 6.8

Pooled Var (X')= 164 (66 d.f.)

S.E.D. 1,2 = 3.70 t= 2.62**
S.E.D 2,3 = 3.83 t= 1.78*

The differencess in zone means still remain, in the same direction, at the same level of significance, even when it is attempted to remove components with ecological bias from the index of risk aversion. This indicates that there is a real inter-zonal difference in the importance of risk in decision-making.

Therefore, in testing the remaining hypotheses, more attention is paid to the significance of intra-zonal differences than to overall comparisons, as these may be confused inter-zonal differences. IRA(A) is used rather than IRA(Z) to test most of the hypotheses, although sometimes one or two components of the index of risk aversion are omitted to test a particular hypothesis.

2. <u>Farmers with large families living at home are more risk-averse than those with small families living at home</u>.

Let X = size of family living at home (adult equivalents) Y = IRA(G) (which omits component 17).

	Zone 1	Zone 2	Zone 3	Overall
n	24	24	21	69
$\bar{X}$	5.54	5.29	4.38	5.10
Var(X)	4.30	7.65	2.62	5.06
$\bar{Y}$	43.21	59.50	70.24	57.10
Var(Y)	143.0	375.9	224.3	364.9
r	0.125 n.s.	-0.144 n.s.	0.224 n.s.	-0.114 n.s.

A positive correlation was expected. For Zone 1 and Zone 3 the sign is as expected. Zone 2 and the overall correlation coefficient have the opposite sign to that anticipated. However none of the correlation coefficients differ significantly from zero. Therefore no relationship between size of family living at home and risk aversion is indicated by the data. The null hypothesis therefore cannot be rejected in favour of hypothesis 2.

3. Farmers with higher commitment for school fees take more risks than those with fewer children at School.

Let X = commitment for school fees
Y = IRA(A)

	Zone 1	Zone 2	Zone 3	Overall
n	24	24	21	69
$\bar{X}$	759.8	457.5	1600	910.4
Var(X)	477,000	290,800	509,000	1984,000
$\bar{Y}$	44.71	62.88	74.29	60.03
Var(Y)	223.8	358.9	242.5	416.9
r	-0.1257 n.s.	-0.0257 n.s.	0.0818 n.s.	0.1291 n.s.

For Zone 1 and Zone 2, the sign of the correlation coefficient is negative as expected. For Zone 3 and the sample as a whole the correlations have the opposite sign. However all the correlation coefficients are very small in absolute value and none are significantly different from zero. Therefore no relationship between commitment for school fees and risk aversion is indicated by the data. The null hypothesis cannot be rejected in favour of hypothesis 3.

4. <u>Younger farmers take more risks than older farmers</u>

Let X = approximate age (mid-point of age class)
Y = IRA (A)

	Zone 1	Zone 2	Zone 3	Overall
n	24	24	21	69
$\bar{X}$	55.00	49.17	56.43	53.41
Var(X)	113.0	208.0	162.9	166.5
$\bar{Y}$	44.71	62.88	74.29	60.03
Var(Y)	223.8	358.9	242.5	416.9
r	-0.3991	0.3426	0.0733	0.0565
	n.s.	10%	n.s.	n.s.

All the correlation coefficients have the positive sign expected except for Zone 1 where there is a fairly large negative correlation, although it is not significant by a 2-tailed test. For Zone 2 the positive correlation is significantly different from zero at the 10% level and almost so at the 5% level. The zone 3 and overall correlation coefficients are very small in size and not significant.

Thus within Zone 2 hypothesis 4 appears to hold true, whereas for Zone 1 younger farmers seem to be more risk averse than older farmers.

5(a) Farmers with agricultural training (i.e. who have attended at least one course at a Farmers' Training Centre) take more risks than those who do not

Let X = IRA (A)

		Zone 1	Zone 2	Zone 3	Overall
With agricultural training	n	10	4	9	23
	$\bar{X}$	47.0	49.5	79.6	60.2
	Var(X)	372	314	185	
Without agricultural training	n	14	20	12	46
	$\bar{X}$	43.1	65.6	70.3	60.0
	Var(X)	132	340	267	
Difference in means (with-without)		3.9	-16.1	9.3	0.2
S.E.D.		6.78	8.97	7.22	4.18
t		0.58	1.79*	1.29	0.05
		N.S.		N.S.	N.S.

Pooled Var (X) = 268 (63 d.f.)

5(b) Farmers who have had some training (apart from school or farmers training centres) take more risks

Let X = IRA (A)

		Zone 1	Zone 2	Zone 3	Overall
With training	n	5	4	8	17
	$\bar{X}$	49.8	69.8	85.0	71.1
	Var(X)	102	47	175	
Without training	n	19	20	13	52
	$\bar{X}$	43.4	61.5	67.7	56.4
	Var(X)	254	415	179	
Difference in means (with-without)		6.40	8.30	17.30	14.70
S.E.D.		8.1	8.83	7.25	4.50
t		0.79 n.s.	0.94 n.s.	2.39*	3.27**

Pooled Var (X) = 260 (63 d.f.)

A 1-tailed test was specified: it was expected that farmers who had attended Farmers' Training Centres would have a lower value of IRA than those who had not. This holds true in Zone 2, where the difference in mean values of IRA between farmers with and without agricultural training is significant at the 5% level. No other differences are significant, moreover all other differences have the opposite sign from that expected, i.e. the farmers with agricultural training in Zone 1, Zone 3 and overall are more risk-averse than those without agricultural training, although not significantly so.

Thus the data tend to confirm hypothesis 5(a) in Zone 2: the null hypothesis of no significant correlation can be rejected for that Zone, but for other zones the results are inconclusive.

Here again a 1-tailed test was specified: it was expected that farmers with other training would have a lower value of IRA than those without. However for each Zone, and overall, the difference in means is positive. Applying a 2-tailed test, this positive difference is significant for Zone 3 at the 5% and overall at the 1% levels. Thus the data for Zone 3, and overall, indicates that farmers who have had some other training are more risk-averse. More emphasis should be placed on this result for farmers within Zone 3 than overall. The overall result is affected by the fact that the proportion of farmers in Zone 3 who have had other training is about twice that in each of the other two zones, and the mean value of IRA for farmers in zone 3 is significantly lower than for farmers in zone 1 or zone 2.

However for zone 3 both the null hypothesis and Hypothesis 5(b) are, rejected.

6. <u>Farmers with more years of schooling take more risks.</u>

Let X = number of years of schooling

Y = IRA (A)

	Zone 1	Zone 2	Zone 3	Overall
n	24	24	21	69
$\bar{X}$	3.13	3.58	2.71	3.16
Var(X)	9.94	9.38	9.32	9.40
$\bar{Y}$	44.71	62.88	74.29	60.03
Var(Y)	223.8	358.9	242.5	416.9
r	0.1492 n.s.	-0.0616 n.s.	0.1691 n.s.	0.0349 n.s.

The signs of the correlation coefficients were expected to be negative: However apart from in Zone 2, they are positive, but none significantly so. The negative correlation in Zone 2 is negligible, and none of the other correlation coefficients differ significantly from zero. Thus no relationship between years of schooling and risk aversion is indicated by the data. The null hypothesis cannot be rejected.

7. Farmers who have been on the farm for a long time take more risks than more recent arrivals.

Let X = number of years for which the farmer has lived on that farm

Y = IRA (A)

	Zone 1	Zone 2	Zone 3	Overall
n	24	24	21	69
$\bar{X}$	21.0	21.9	17.1	20.1
Var(X)	183.0	255	44.75	165.6
$\bar{Y}$	44.71	62.88	74.29	60.03
Var(Y)	223.8	358.9	242.5	416.9
r	-0.1805 n.s.	0.0929n.s.	0.1650n.s.	-0.0544n.s.

None of the correlation coefficients differ significantly from zero. Therefore no relationship is indicated by the data between the length of time spent on the farm and the index of risk aversion. The null hypothesis cannot be rejected.

8. Wealthier farmers take more risks

Let X = Log_e (estimated wealth in K.shs(000))
Y = IRA (B)

	Zone 1	Zone 2	Zone 3	Overall
n	24	24	21	69
$\bar{X}$	2.7	1.6	2.5	2.2
Var(X)	0.58	1.00	2.40	1.47
$\bar{Y}$	31.4	45.3	56.0	43.7
Var(Y)	213.0	334.8	208.3	347.4
r	0.3048 n.s.	-0.2237ns	0.2772n.s.	0.0344 n.s.

When two-sided tests are performed, none of the correlation coefficients differs significantly from Zero. Therefore no relationship between loge (estimated wealth) and index of risk aversion is indicated by the data. The null hypothesis cannot be rejected.

Note on the log transformation:†

The distribution of estimated wealth was, as is usual, positively skew. The variance was extremely high in Zone 3. To test the null hypothesis that the population correlation coefficient is zero, it is sufficient that one of the variates (Y in this case) is normally distributed.* However a more powerful test may be made if X is transformed so as to approximate more closely a normal variate. Therefore the test is performed by calculating the correlation coefficients between IRA (B) and $\log_e$(estimated wealth).

*(Snedecor and Cochran Statistical Methods P185)

9. Higher-income farmers take more risks

Let X = Loge (estimated total income),
Y = IRA (D)

	Zone 1	Zone 2	Zone 3	Overall
$\bar{X}$	8.77	7.97	7.52	7.87
Var(X)	1.92	3.68	4.02	3.22
r	-0.1223n.s.	0.2545n.s.	-0.0527ns	-0.0562 n.s.

Let FX = Loge (estimated from income)
Y = IRA (D)

	Zone 1	Zone 2	Zone 3	Overall
$\overline{FX}$	7.83	6.65	6.03	6.87
Var(FX)	1.06	3.17	6.86	4.02
r	-0.1269n.s.	0.0763 n.s.	-0.0983 n.s.	-0.2181 n.s.

The distribution of income, like that of wealth is positively skew so again a log transformation has been made.

The correlation coefficients between $\log_e$ (estimated total income) and IRA(D) are all negative apart from that for zone 2, but none differ significantly from zero, although their sign is in the direction to support the hypothesis. This is so also for the correlation coefficients between IRA (D) and $\log_e$ (estimated total farm income), although again none is significant. Thus the data do not indicate any relationship between risk aversion and log(estimated total income) or log(estimated farm income). The null hypothesis cannot be rejected.

10. <u>Farmers who own a vehicle (Matatu, bicycle, ox or donkey-cart) take more risks than those without</u>

Let X = IRA (A)

		Zone 1	Zone 2	Zone 3	Overall
With vehicle	n	8	10	10	28
	$\bar{X}$	37.4	62.9	77.8	60.9
	Var(X)	264	381	354	
Without vehicle	n	16	14	11	41
	$\bar{X}$	48.4	62.9	71.1	59.4
	Var(X)	177	371	143	
Difference in means (with-without)		-11.0	0	6.70	1.50
S.E.D.		7.19	6.88	7.26	4.07
t		1.53(10%)	0 n.s.	0.92 n.s.	0.37 n.s.

Pooled Var (X) = 276 (63 d.f.)

A 1 tailed-test was specified. The value of IRA was expected to be lower for vehicle-owners than for non-vehicle owners. For Zone 1 this is so but the negative difference between means is significant only at the 10% level. The data thus indicate a weak confirmation of hypothesis 10 for farmers in Zone 1. For Zone 2 the difference in mean value of IRA between vehicle owners and non-owners is zero and for Zone 3 and overall, the difference has the opposite sign to that expected but is not significant. Thus for Zones 2 and 3 the null hypothesis cannot be rejected.

There are some problems in grouping together owners of matatus, bicycles and ox or donkey-carts, which gave varying degrees of mobility.

11. <u>More 'progressive' farmers take more risks</u>

Let X = index of progressivity

Y = IRA (C) (which omits Component 6 of IRA (A)

	Zone 1	Zone 2	Zone 3	Overall
n	24	24	21	69
$\bar{X}$	13.83	9.74	6.71	10.24
Var(X)	7.49	8.96	13.73	18.22
$\bar{Y}$	43.50	61.88	71.48	58.41
Var (Y)	232.8	336.1	247.3	400.6
r	0.3226n.s.	0.1732n.s.	0.3550n.s.	-0.2309*

All correlation coefficients, except the overall one, have a positive sign as opposed to the negative sign which was expected. None of these positive intra-zonal correlations, however, differs significantly from zero.* The overall correlation coefficient has the expected negative sign and is significantly different from zero at the 5% level. Its significance must be interpreted with caution however, since it is mainly caused by the between zone differences. There is a downward trend is mean values of the index of progressivity from Zone 1 to Zone 3 combined with an upward trend in index of risk aversion from Zone 1 to Zone 3.

The data do not indicate any significant relationship between progressivity and risk-taking. The null hypothesis therefore cannot be rejected.

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* None however are negligeable. Those for Zones 1 and 3especially are fairly large. This seems to give some indication that the improvements used in calculating the index of progressivity are risk-reducing. This is an interesting result because it refutes the frequent assertion that innovation is necessarily risk-taking and conservative behaviour is necessarily risk averse. This confirms some premises of the theory of risk put forward in chapter 5 (A).

12. <u>Farmers who are near to the road take more risks</u> Let X = IRA (A)

		Zone 1	Zone 2	Zone 3	Overall
Near	n	16	17	12	45
	$\bar{X}$	45.5	62.9	74.8	59.9
	Var(X)	134	403	232	
Far	n	8	7	9	24
	$\bar{X}$	43.1	62.9	73.6	60.3
	Var(X)	445	300	286	
Difference in means(near-far)		2.4	0	1.2	-0.4
S.E.D.		7.19	7.46	7.33	4.20
t		0.33 n.s.	0 n.s.	0.16 n.s.	0.10 n.s.

Pooled Var (X) = 276 (63 d.f.)

A 1-tailed test was specified. The mean value of IRA for farmers near to the road was expected to be smaller than that for farmers or farms further from the road. In Zone 2 the difference in means is zero whereas in Zone 1 and Zone 2 the difference is positive, the opposite to what was expected. Only the overall difference in mean values of index of risk aversion between farmers near and far from the road has the expected negative sign. This may be caused by the fact that the proportion of farmers near to the road was higher in Zone 1 and Zone 2 than in Zone 3.

None of the differences are significant.

There are problems in defining distance and 'the road', which may confuse the test.

The data do not lend support to Hypothesis 12: therefore the null hypothesis cannot be rejected.

13. On farms which are divided, less risks are taken Let X = IRA (A)

		Zone 1	Zone 2	Zone 3	Overall
Divded	n	3	6	12	21
	$\bar{X}$	45.0	35.8	71.8	57.7
	Var(X)	91	577	296	
Undivided					
	n	21	18	9	48
	$\bar{X}$	44.7	66.3	77.4	58.9
	Var(X)	248	404	186	
Difference in means (divided-undivided)		0.3	-30.50	-5.60	-1.20
S.E.D.		10.90	8.33	7.79	4.62
t		0.03	3.66***	0.72 n.s.	0.24 n.s.

Pooled Var(X) = 312 (63 d.f.)

A 1-tailed test was specified since the differences in mean values of IRA between divided and undivided farms was expected to be positive. In fact this is true for Zone 1 but for Zones 2 and 3, and overall, the differences are negative, the only one which is significantly different from zero, (applying a 2-tailed test) being in Zone 2. It is significant at the 0.1% level. This indicates that in Zone 2 more risks are taken on divided farms while farmers on undivided farms are more risk averse. Perhaps it is the less risk-averse who are more generous in giving part of their farm to be cultivated by relatives, or perhaps there is a risk involved in doing so.

The farms classified as divided were not very homogeneous because in most cases the division only entailed giving one or two acres to be cultivated by a mother or a son, whereas a few farms were divided into two almost equal pieces. Moreover certain essumption had to be made about acreages of crops grown for divided farms which made that data less reliable than for undivided farms.

14. Farmers who hire additional land on another farm take more risks. Let X = IRA(A)

Since only 5 farmers hired additional land, no intra-zonal comparison was made for this hypothesis, only an overall one.

	Farmers who hire land	Farmers who do not hire land
n	5	64
$\bar{X}$	73.8	59.0
Var(X)	534	400

Pooled Var(X) = 408 (67 d.f.)

Difference in means (hire - don't hire) = 14.8

S.E.D. = 9.38

t = 1.58 n.s.

The t value is not significant although it is fairly high. The mean value of IRA is higher for farmers who hire land than for those who do not. This could be because three out of the 5 farmers who hired extra land were in Zone 3 where values of IRA are generally higher.

Insufficiency of data prevented intrazonal comparisons from being made.

15. <u>Farmers who hire out part of their farm are more risk averse</u>

Let X = IRA(A)

		Zone 1	Zone 2	Zone 2 and 3	Zone 3	Overall
Hire	n	0	7	(12)	5	12
	$\bar{X}$	-	72.9	(72.8)	72.6	72.8
	Var(X)	-	230		350	
Don't hire	n	24	17		16	
	$\bar{X}$	44.7	58.8	(66.6)	74.8	57.4
	Var(X)	224	368		229	
Difference in means (hire-don't hire)		-	14.1	(6.20)	-2.2	15.4
S.E.D.			7.38	(5.58)	8.42	5.17
t			1.91(10%)	(1.11n.s.)	0.26n.s.	2.98**

Pooled Var(X) = 270 (64 d.f.)

The difference in means for Zone 3 is not significantly different from zero but the overall difference in mean values of IRA between farmers who hire out part of their farm and farmers who do not is significant at the 1% level. This seems to indicate that farmers who hire out part of their farm are more risk averse, confirming the hypothesis, but the result must be interpreted with caution again because of inter-zonal differences. Farmers who hire out some land are either in Zone 2 or Zone 3, not in Zone 1, and mean values of IRA are higher in lower zones. However for Zone 2 the difference is significant at the 10% level which would also tend weakly to confirm hypothesis 15. For Zone 2 and 3 combined the difference is not significant. For Zone 3 the null hypothesis cannot be rejected.

16. Farmers who have relatives living nearby take more risks

Let X = IRA(A)

		Zone 1	Zone 2	Zone 3	Overall
Relatives living	n	19	17	13	49
nearby	$\bar{X}$	44.8	64.7	73.8	59.4
	Var(X)	271	358	228	
No relatives	n	5	5	8	18
living nearby	$\bar{X}$	44.4	57.8	75.1	61.8
	Var(X)	67	532	301	
Difference in means(relatives-no relatives)		0.4	6.90	-1.30	-2.40
S.E.D.		8.60	8.71	7.69	4.72
t		0.05n.s.	0.79n.s.	0.17ns.	0.51 n.s.

Pooled Var (X) = 293 (61 d.f.)

Here none of the differences are significant and the t-values are very small. No relationship between having relatives living nearby and risk aversion is indicated by the data, perhaps partly because the definition of nearby was rather subjective. The null hypothesis cannot be rejected.

17. Farmers who have a greater acreage take more risks than those owning only a small plot

Let X = acreage for which the family is responsible

Y = IRA (A)

	Zone 1	Zone 2	Zone 3	Overall
n	24	24	21	69
$\bar{X}$	7.6	6.5	17.4	10.2
Var(X)	15.57	9.50	179.60	84.55
$\bar{Y}$	44.71	62.88	74.29	60.03
Var(Y)	223.8	358.9	242.5	416.9
r	-0.1009n.s.	-0.174n.s.	0.3494n.s.	0.8499**

None of the intra-zonal correlation coefficients differs significantly from zero. However the overall correlation coefficient is significant at the 0.1% level. This again is caused mainly by inter-zonal differences. The mean acreage in Zone 3 is over twice that in Zone 1 while the mean value of IRA in Zone 3 is almost twice that in Zone 1. A 2-sided test was performed because the relationship could be argued either way, and in fact the high overall correlation coefficient has the opposite sign to that framed in the hypothesis. The correlation coefficient which is next highest in absolute value, although not significant, is that in Zone 3. Again it has a positive sign. The variance of acreages is much higher in Zone 3 than in either Zone 1 or Zone 2 and farmers with highest acreages in Zone 3 must tend to have the highest values of IRA. However the null hypothesis cannot be rejected within any zone.

18. Farmers who have a full-time job away from the farm take more risks

Let X = IRA (A)

		Zone 1	Zone 2	Zone 3	Overall
Full-time job	n	8	5	3	16
	$\bar{X}$	47.9	64.6	81.0	59.3
	Var(X)	77	90	91	
No full-time job	n	16	19	18	53
	$\bar{X}$	43.1	62.4	73.2	60.3
	Var(X)	299	438	265	
Difference in means (job-no job)		4.80	2.2	7.8	-1.0
S.E.D.		7.31	8.49	10.53	4.82
t		0.66n.s.	0.26n.s.	0.74 n.s.	0.21 n.s.

Pooled Var (X) = 285 (63 d.f.)

Here none of the differences between mean value of index of risk aversion (either within zones or overall) between farmers who have and do not have a full-time job, are significantly different from zero. Overall, the mean value of IRA for farmers with a full-time job is less than the mean for farmers with no full-time job; which is in the direction of the hypothesis, whereas all the intra-zonal differences are in the opposite direction from that postulated by the hypothesis. No relationship between having a full-time job away from the farm, and risk aversion, is indicated by the data. The null hypothesis therefore cannot be rejected.

19. Farmers with a smaller work-force are more risk-averse.

Let Y = IRA(A) X = permanent work-force

	Zone 1	Zone 2	Zone 3	Overall
n	24	24	21	69
$\bar{X}$	2.71	2.58	3.12	2.79
Var(X)	2.04	1.99	2.65	2.21
$\bar{Y}$	44.71	62.88	74.29	60.03
Var(Y)	223.8	358.9	242.5	416.9
r	-0.5147**	-0.2930 (10%)	0.1288 n.s.	-0.1230 n.s.

1-tailed tests indicate the correlation coefficients to be significant at the 1% level in Zone 1 and the 10% level in Zone 2, with the expected negative sign. The overall correlation coefficient is also negative but not significantly different from zero, and for Zone 3 the correlation is positive but insignificant.

Thus for Zone 1 and Zone 2 the null hypothesis of zero correlation can be rejected and Hypothesis 19 appears to be confirmed, strongly in Zone 1 and weakly in Zone 2. For Zone 3 however the data do not indicate any relationship between size of work force and risk-aversion.

20. <u>Farmers who mix a high proportion of their crops are more risk averse than those who grow a higher proportion of pure stand.</u>

Let X = mean proportion of seasonal crops mixed in 2 seasons.

Y = IRA(I) which is IRA(A) but omitting component 14 (=X) and component 1 (reasons for mixing crops)

	Zone 1	Zone 2	Zone 3	Overall
n	24	24	21	69
$\bar{X}$	0.28	0.47	0.54	0.43
Var(X)	0.05	0.15	0.12	0.11
$\bar{Y}$	35.08	47.33	56.29	45.80
Var(Y)	174.3	183.5	287.6	280.9
r	-0.1706ns	0.0014n.s.	-0.5411*	-0.0291n.s.

All the correlation coefficients are very low in absolute value except for Zone 3, where the correlation coefficient has a negative sign instead of the positive sign expected.

If a 2-tailed rather than 1-tailed test is performed this correlation coefficient differs significantly from zero at the 5% level. Thus for the farmers in Zone 3, the data indicate the reverse relationship from that postulated in the hypothesis. Farmers in Zone 3 who mix a high proportion of their crops appear to be less risk averse than those who grow a higher proportion of pure stand. However, for the upper two zones, the null hypothesis cannot be rejected.

21. <u>Farmers who have a high number of enterprises are risk averse</u>

Let X = Component 16 of IRA(A) = number of enterprises x 0.5

Y = IRA(K) which is IRA(A) with component 16 omitted.

	Zone 1	Zone 2	Zone 3	Overall
n	24	24	21	69
$\bar{X}$	7.50	7.79	7.48	7.59
Var(X)	2.11	2.52	6.11	3.38
$\bar{Y}$	33.96	51.67	63.43	49.09
Var(Y)	230.8	321.1	203.9	393.3
r	-0.1567n.s.	0.3428 Significant at 10%	0.2553n.s.	0.1354n.s.

A 1-tailed test was specified because the sign of the correlation coefficient was expected to be positive. All the correlation coefficients are positive except for Zone 1 but the only value of r which is significant is for Zone 2, significant at the 10% level. Therefore for farmers in Zone 2 the hypothesis is weakly confirmed. Also in Zone 3 the value of r is almost significant at the 10% level. For Zone 1 and overall, the data do not indicate any relationship between number of enterprises and risk aversion, or the null hypothesis cannot be rejected.

22. Farmers who have recently introduced new crops are risk-takers.

Let Y = IRA(J) which is IRA(A), omitting component 10: relating to number of new crops introduced and component 3: reasons for introducing new crops.

		Zone 1	Zone 2	Zone 3	Overall
New crops	n	8	[illegible]	11	26
introduced	$\bar{X}$	42.8	67.1	77.2	63.9
	Var(X)	179	64	184	
No new crops	n	16	17	10	43
introduced	$\bar{X}$	47.3	63.5	78.4	60.9
	Var(X)	271	486	326	
Difference in means (new crops-no new crops)		-4.50	3.60	-1.20	3.0
S.E.D.		7.39	7.66	7.45	4.24
t		0.61n.s.	0.47n.s.	0.16n.s.	0.71n.s.

Pooled Var(X) = 2 91 (63 d.f.)

None of the differences are significant. According to the hypothesis they would be negative. This is so for Zone 1 and 3 but not for Zone 2 and overall.

Thus the data do not indicate any relationship between the introduction of new crops and risk-taking. The null hypothesis cannot be rejected.

23. Farmers who grow a high proportion of food and multi-purpose crops are more risk-averse

Let X = Mean proportion of food and multi-purpose crops grown in 2 seasons = Component 13 of IRA(A)

Y = IRA(B) which is IRA(A) omitting Component 13.

	Zone 1	Zone 2	Zone 3	Overall
n	24	24	21	69
$\bar{X}$	0.64	0.83	0.87	0.78
Var(X)	0.03	0.02	0.02	0.03
$\bar{Y}$	213.0	334.8	208.3	347.4
r	0.0082n.s.	0.1486n.s.	0.2795 n.s.	0.3901**

A 1-tailed test was specified because the correlation coefficient was expected to be positive. All the values of r have the expected positive sign but none differ significantly from zero except the overall value. The overall correlation coefficient is significant at the 1% level. This result should again be treated with caution because it reflects the effect of difference between zones, as shown by the upward trend in mean values of both the proportion of food and multi-purpose crops and the index of risk aversion from Zone 1 to Zone 2 to Zone 3. Within Zone 3, the correlation coefficient is almost significant at the 10% level which may indicate a more genuine relationship. Within Zone 1 and Zone 2, no relationship between proportion of food and multi-purpose crops grown and index of risk aversion is indicated by the data. The null hypothesis, therefore, cannot be rejected.

24. Farmers who plant early are risk-takers

Let X = IRA(C) which omits component 6 of IRA(A), relating to time of planting.
Let early planters denote farmers who plant all their crops before the first rains.
Let late planters denote farmers who plant all their crops after the first rains.

		Zone 1	Zone 2	Zone 3	Overall
Early	n	7	4	0	11
planters	$\bar{X}$	47.7	61.3	-	52.6
	Var(X)	30.7	90.6	-	
Late	n	11	6	17	34
Planters	$\bar{X}$	39.4	61.8	71.5	59.4
	Var(X)	147	363	272	
Difference in means (early-late)		8.30	-0.50		-6.80
S.E.D.		8.33	11.12	-	5.98
t		1.02n.s.	0.04n.s.	-	1.14n.s.

Pooled Var(X) = 297 (58 d.f.)

None of the t values show significance so the data do not indicate any relationship between time of planting and risk aversion.

According to the hypothesis, the differences would be expected to be negative. This is so overall and in Zone 2, but the difference in mean value of IRA between early planters and late planters in Zone 1 is negative. Perhaps this is because of the difficulty of ascertaining time of planting in Zone 1 because of the 'gathano' rains and the fact that most farmers only plant crops once a year.

The null hypothesis cannot be rejected.

25. <u>Farmers who have had a loan of money take more risks than those who have not</u>

Let X = IRA(F) which is IRA(A) with component 7, which relates to having had a loan of money, omitted.

		Zone 1	Zone 2	Zone 3	Overall
Loan of money	n	13	9	7	29
	$\bar{X}$	48.4	65.7	78.7	61.1
	Var(X)	239	261	90	
No loan of money	n	11	15	14	40
	$\bar{X}$	47.9	62.8	72.9	62.2
	Var(X)	129	434	320	
Difference in means(loan - no loan)		0.5	2.9	5.8	-1.1
S.E.D.		6.73	6.93	7.61	4.01
t		0.07n.s.	0.42n.s.	0.76n.s.	0.27n.s

Pooled Var (X) = 270 (63 d.f.)

None of the t values indicate that the differences between means are significant.

According to the hypothesis, the differences in mean values of IRA between farmers who have had loans of money and those who have not should be negative. Here the overall difference is negative as expected but the other differences are all positive, but not significantly so.

Thus the data do not indicate any relationship between having had a loan of money and risk-aversion. The null hypothesis cannot be rejected.

There is a difficulty in grouping together the few farmers who have had a relatively risky loan from a bank with the majority of farmers who have had a relatively safe loan from the Coffee Co-operative Society.

26. <u>Farmers with smaller holdings often plant larger proportions of their land with cash crops than slightly larger farmers</u>.

Let X = acreage for which the family living on the farm is responsible.

Y = Mean proportion of cash crops grown in two seasons.

	Zone 1	Zone 1 and 2 Combined	Zone 2	Zone 3	Overall
n	24	(48)	24	21	69
$\bar{X}$	7.63	(7.07)	6.51	17.43	10.22
Var(X)	15.56	(12.58)	9.50	179.6	84.57
$\bar{Y}$	0.36	(0.26)	0.17	0.13	0.22
Var (Y)	0.0261	(0.0304)	0.00164	0.0220	0.0314
r	-0.1184 n.s.	(0.0799)n.s.	0.1620n.s	-0.2366n.s.	-0.2488*

The 2-tailed test indicates only the overall correlation coefficient to be significantly different from zero, at the 5% level. This tends to support Hypothesis 26 but is caused mainly by inter-zonal differences.

In Zone 3, many farmers grow no crop specifically for cash, but only food and multi-purpose crops. If therefore Zone 3 is omitted, the correlation coefficient for Zones 1 and 2 combined may be calculated. However it is very small in absolute value.

The null hypothesis of no significant correlation therefore cannot be rejected within any zone, and there is little evidence to support Hypothesis 26.

CHAPTER EIGHT

A. Summary of results

At this point it should be re-emphasised that statistical significance of a t-value or a correlation coefficient is more meaningful within a particular zone than overall, Overall significance is usually caused by the wide ecological differences between the three zones, especially for the correlation coefficients. This is why, for some hypotheses, the overall correlation coefficient differs significantly from zero while none of the intra-zonal correlation coefficients do. For the t-tests, overall significance could reflect that the data tend to confirm the hypothesis provided that there is zonal balance: that is, provided that the proportion of farmers within each of the two categories between which differences in means are being tested, remains approximately constant from Zone to Zone. This condition is in practice rarely met.

More meaningful results would be obtained if there were significance of t or r simultaneously in each of two or more zones, whether or not the overall t or r were significant. In fact, when there is significance, it is usually only for one Zone in the results above.

Results showing any significance are shown in Table 8.1.

The strongest significant differences are between Zones, the significance level being higher between Zones 1 and 2 than between Zones 2 and 3. The significant differences between mean values of the index of risk aversion are still apparent when components which are heavily dependent on ecological factors are removed from the index. Each zone represents a different stage in the transition from a subsistence to a cash economy. Farmers in Zone 1 produce the cash crops coffee and tea, coffee plays an important role also in Zone 2, while in Zone 3 cash crops are only beginning to make an impact. The cash crops suitable for Zone 3 are seasonal crops such as sunflower and cotton. They are quite likely to fail because of insufficient rain.

Table 8.1 Summary of Results

Hypothesis	Zone 1	Zone 2	Zone 3	Overall
1. Between Zones using IRA(A)	1% Expected sign	5% Expected sign		
Between Zones Using IRA(Z)	1% Expected sign	5% Expected sign		
4. Age	-	10% expec-ted sign	-	-
5.(a)FTC	-	5% Expec-pected sign	-	-

Table 8.1 - Summary of results (Contd...)

Hypothesis	Zone 1	Zone 2	Zone 3	Overall
5(b) Other Training	-	-	5% Opposite Sign	5% Opposite sign
10. Vehicle ownership	10% Expec-ted sign	-	-	-
13. Divided farms	-	0.1% Opposite sign	-	-
15. Hiring land to others	-	10%	-	1%
17. Acreage	-	-	-	0.1%
19. Size of work-force	1% Ex-pected sign	10% Expec-ted sign	-	-
20. Proportion of crops mixed	-	-	5% Opposite sign	

Table 8.1 Summary of results (Contd...)

Hypothesis	Zone 1	Zone 2	Zone 3	Overall
21. Number of enterprises	-	10% Expected sign	-	-
23. Proportion of food and multi-purpose crops	-	-	-	1% Expected sign
26. Size of holding, Prop^n cash crop	-	-	-	5%

The zones vary considerably as to how many results show significance, and which hypotheses are confirmed at what level of significance.

ZONE 1 For Zone 1, two tests show significance, at the 10% and 1% levels respectively, for hypotheses (10) and (19). Both were one-tailed tests and in both cases the sign is as expected. Thus the hypothesis that farmers owning vehicles are less risk averse than those without is weakly confirmed. However, this could be confused with a wealth effect. The hypothesis that farmers with a smaller regular work-force are more risk averse is strongly confirmed. This might reflect the fact that the labour constraint is over-riding, especially since the same hypothesis is also confirmed, although weakly so, in Zone 2. The tabulated results of the answers to question 54 of the questionnaire reveal that unavailability of labour was a particularly severe problem for farmers in Zone 1, and that lack of money to hire labour was also an important problem in all zones, especially in the upper two. The[illegible] problemss however may have referred more to the hiring of casual than regular labour. Too much work was also an important problem especially in Zones 2 and 3.

Since hypothesis (19) is the only hypothesis to be confirmed in more than one zone, the index of risk aversion may be emphasising risk aversion associated with a labour constraint.

The fact that only two hypotheses are confirmed in Zone 1 may be because risk aversion does not play a very important part in decision making there because the farmers are reasonably prosperous. This point is discussed more fully in the conclusion (Section B).

ZONE 2 For Zone 2, six tests show significance, four at the 10% levels only, one at the 5% and one at the 0.1% levels. Of these, five tests were one-tailed and four had the expected sign, the other (hypothesis 13) having the opposite sign. The other test was two-tailed but the test confirmed the hypothesis as stated.

The hypothesis that younger farmers take more risks while older farmers are more risk-averse is weakly confirmed. It may be noted here that the sample farmers in Zone 2 and a slightly lower mean age and a considerably lower modal age group, than the farmers in the other two zones. Moreover the variance of age was highest in Zone 2. The hypothesis that farmers who have attended Farmers' Training Centres are less risk averse is also confirmed. Farmers on divided farms appear to be less risk-averse than those on undivided farms, which is strongly contrary to hypothesis 13. There is a weak indication that farmers who hire land to others are more risk-averse than those who do not. There is also a weak confirmation that farmers who diversify their farm enterprises are more risk-averse. It may be noted here that diversity of enterprises is more likely to be found where there is a labour constraint, since diversifying spreads the labour peaks. The hypothesis that farmers with a smaller work-force are more risk-averse is weakly confirmed.

It might be asked why Zone 2 is the zone where the largest number of hypotheses are confirmed, even though four out of the six tests only show significance at the 10% level. In Zone 2 there is less risk of rains failing than in Zone 3, but there is an important land constraint. The tabulation of question 1 of the questionnaire shows that the mean farm size in Zone 2 is lower than in either of the other two zones, as is the acreage for which the interviewee, or the family, is responsible. The standard deviations of acreages are also lowest in Zone 2. So even though there is less rainfall risk than in Zone 3, a substantial proportion of farmers in Zone 2 are fairly close to subsistence because of the land constraint. Moreover, the answers to question 54 of the questionnaire reveal that shortage of land is an important problem for a higher proportion of farmers in Zone 2 than in either of the other two zones. In Zone 1 the mean farm size is not much higher than in Zone 2 but rainfall is much more reliable. Another reason why more tests of hypotheses show significance in Zone 2 than in any other zone may be because the variance of the index of risk aversion is highest in Zone 2.

ZONE 3: In Zone 3 only two tests show significance, both at the 5% level, although both are 1-tailed tests and have the opposite sign from that expected. Thus farmers who have attended other training apart from School or Farmers' Training Centres appear to be more risk averse than those who have not. This may be because farmers with such other training have opportunities to go into other business, relying on it for a steady income and neglecting the farm. The high risk of insufficient rain will be an exacerbating factor. Also in Zone 3, farmers who mix a high proportion of their crops appear to be less risk-averse than those who mix a lower proportion, contrary to the hypothesis. However, in a dry area, in a poor season, yields can be less from maize/bean mixture than for pure stand, since beans do reduce maize yields and do not necessarily make up for this reduction with their own yield.*

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*Republic of Kenya, Ministry of Agriculture, Horticultural Handbook, Vol. 2. 1976 10 Beans. For a discussion of the efficacy of mixed crops in reducing risk under Kenyan conditions see: Fisher, N.M. (1977) Studies in mixed cropping. 1. Seasonal differences in relative productivity of crop mixtures and pure stands in the Kenya Highlands. Experimental Agriculture 13 (2) and: Fisher, N.M. (1976) Experiments with maize-bean and maize potato mixed crops in an area with two short rainy seasons in the highlands of Kenya.
Paper for Symposium on Intercropping in Semi-Arid Areas. Morogoro, Tanzania,May,1976.

So in Zone 3, a greater risk would be taken by mixing crops than by growing pure stand (for maize and beans at least). The yield could be higher from the mixture in a good season but there would be higher variability. However for upper areas where the risks are not too little, but too much rainfall, hail, pests etc. mixing crops may be considered risk-averse

B. Conclusion, and limitations of this study

It remains to consider to what extent risk-aversion played an important in decision-making for the farmers in Kabare Location. It appeared that risk aversion was more important in the more risky environment of Zone 3 and the lower part of Zone 2, as indicated by higher values of the index of risk aversion and more significant results to tests of hypotheses. Even in Zone 3 many were not strictly subsistence farmers (that is those who do not have cash crops and do not sell farm produce apart from occasional small surpluses of food crops), as opposed to those studied by Lynam in Machakos Division. In Zone 1 and most of Zone 2 many of the farmers were progressive, and had moved into the cash economy, with considerable reserves of creditability and liquid assets. This was evident from the security they shared as members of the Kabare Coffee Co-operative Society, and their ownership of assets in the farm of grade cows, bicycles, radios etc. which could easily be cashed if difficulties arose.

For such farmers, who have already definitely "taken-off" from subsistence to commercial farming, it may be that risk aversion does not play an important part in their decision-making. This would explain low values of the index of risk aversion, and the fact that many of the hypotheses on characteristics of risk-averse farmers are not substantiated by the data, especially in Zone 1. In such circumstances there may not be a truly 'risk-averse farmer', that is, one who consistently makes decisions on the basis of risk-aversion (as shown by his high score for each component of the index of risk-aversion).

The farmer's risk aversion perhaps cannot be reduced to a single index of measurement. There may be different kinds of risk aversion, and each farmer may therefore only try to avoid risk in a few different ways, which would be hidden in the index. Risk aversion may only affect part of the farming behaviour, rather than all of it, as is the implicit assumption here. For example, a farmer might be risk-averse with subsistence crops and risk-taking with cash crops. Therefore, if a single component could be found which measured one aspect of risk aversion well, some hypotheses could be better tested by using it rather than the complete index.

This study, therefore, does not give much evidence to support an important role for risk aversion in farmer's overall decision-making, especially in the higher zones.

Other reasons why not more of the hypotheses are supported by the data could be because some hypotheses are not independent of others, or that the index of risk aversion is not isolating risk-aversion alone, but is also measuring other attributes of the farmer. Moreover, many components of the index are affected to a high degree by inter-zonal differences.

To overcome some of these difficulties, regression might be used instead of correlation. Dummy variables inserted for two of the three zones would be one way to isolate the inter-zonal differences. Running multiple regressions to test group of the hypotheses simultaneously would be helpful in cases where some of the attributes of farmers being tested against the index of risk aversion are inter-related. A regression technique which could overcome problems of multi-collinearity, would have to be used in such circumstances.

A limitation of the analysis presented here is the construction of the index of risk-aversion. If this were to be re-worked, some components might be omitted and other different ones included. At present there are a few contradictions among components and some components may over-emphasise other behavioural aspects of the farmer apart from risk aversion.

As well as the choice of components to be included in the index, the scoring and weighting systems could also be reviewed, to see how sensitive the index is to changes in those procedures, which are both too subjective at present. Although they were performed carefully in the limited time available, they are open to some criticism. At present the scoring system introduces some biases. For example, the components: 'food stored per person' (17) and 'net outflow of staples'(15) are constrained to have a maximum of 12 when they are multiplied by the scale factor. For some other components the highest score is less than 12, so 12 is not necessarily the extreme value of risk aversion for all components. Some account, however, has been taken of this fact in the weighting system. As for the weighting, criterion (B), which concerns the reliability of data, could perhaps better be treated by a technique for dealing with random errors.

One way of improving the index, both with regard to the components included and the weights used, would be to let the data generate its own weights, according to a 3-stage procedure. First, a weight of one would be used for each component. Correlation coefficients would then be computed between each component and the sum of the remaining components. Any component having a negative or zero correlation with the sum of the remaining components would be rejected. The positive correlation coefficients would be taken as weights in the new index. The procedure would then be repeated, and the new correlation coefficients which were positive, would be used as weights in the final index, any components with zero or negative correlation with the rest of the index, again being rejected.

Even if the index were changed on the above lines, it is considered unlikely that there would be much reversal of ordering between more and less risk-averse farmers. Therefore, despite the above limitations, the technique is not rejected. If it were refined it could be used widely in developing countries, because of its ease of application. Other methods for measuring risk-aversion such as attempting to obtain the farmers' utility functions by questioning about hypothetical gambling situations, would be far more difficult to apply for unsophisticated farmers, and the results would be much more suspect.

Another approach which has been used, for instance by Lynam*, is that of relating farmers' observed decisions on production, to rainfall variability. This meets considerable difficulties with respect to data availability. Time series yield data are necessary to construct a risk-index based on variability of output. Such data are usually unavailable and have to be simulated for each crop from a rainfall distribution.

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*Personal communication Dec. 1976

This study gives what is hoped is a useful summary picture of small-scale farming in Kirinyaga District, in Chapter 4. It also puts forward a new technique for measuring risk-aversion by small farmers, and suggests that if this technique were improved, it could have wide usefulness in developing countries, especially in areas which are less far advanced towards commercial farming, where risk may be more binding on the decisions made than it was in the upper parts of Kabare Location.

C. Some policy implications.

From the results on risk aversion it would seem that agricultural extension in Zones 2 and 3 needs to promote improvements which take account of the farmers' risk aversion. This is not so important in Zone 1 where most farmers are probably profit-maximisers. In fact, the positive correlations between the index of progressivity and the index of risk aversion found in all Zones for hypothesis 11, though not statistically significant, would seem to suggest that improvements such as application of fertilizer, insecticide, fungicide, introducing grade cows, fencing and early planting may be seen by farmers as risk-reducing.

It has been noted that farmers in Zones 1 and 2 have a great advantage in being able to grow coffee and also tea in Zone 1. For farmers in Zone 3, the only available cash crops are seasonal ones such as sunflower and cotton. However such cash crops at present have a fairly low price and while maize and bean prices remain high, these do provide reasonable cash crops while giving a better chance of meeting subsistence requirements in a bad year. Therefore the farmers should not be discouraged from growing maize and food beans to sell as well as for food.

Some other results, though not related to risk, suggest further policy implications:

From questions 54 and 15(b), it is apparent that there is a severe seasonal labour constraint. Part of this is because of unavailability of labour (for tea and coffee picking in Zone 1) and even more binding is lack of money to hire labour for farmers in all Zones. Perhaps credit for paying labour could be made more widely available through the Coffee Cooperative than it is at present. It seems paradoxical that labour should be a constraint when in lower areas and in towns, there may be unemployment. Perhaps legislation to increase agricultural wages and encourage labour mobility could alleviate this situation. Also, question 36 indicates that there is scope for water development in Zones 2 and 3 as most of the farmers do not have piped water. Labour could then be released from water-carrying for more productive use on the farm.

Farmers in Zone 3, as well as having adverse weather conditions are at a further disadvantage in that they lack the credit facilities which are available to coffee growers. Perhaps alternative credit sources could be developed for Zone 3, for example through loans for sunflower growers.

Questions 54 and 43 reveal that shortage of money is a problem for many farmers and apart from paid jobs, very few farmers have other lucrative occupations. Owning a duka or matatu is beyond the reach of most small farmers. Perhaps rural industries and crafts could be encouraged through a training programme. These would employ labour at off-peak seasons and provide additional income.

Question 5 shows that there is scope for upgrading of cattle in Zones 2 and 3, except where local breeds are definitely preferred for draft purposes.

Question 1(b) shows that there is much informal division of farms, and 15(b) gives shortage of land as an important reason for not growing more of the most profitable crops. This informal subdivision may ultimately reduce marketed production.

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