AN INVESTIGATION OF SOME ECONOMIC IMPACTS OF FEEDER ROADS IN RURAL AREAS: A CASE STUDY OF THIKA DISTRICT, KENYA

BY

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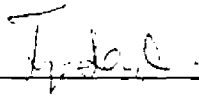
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DECLARATION

This Thesis is my original Work and has not been Presented for a Degree in any other University.

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Joseph Ng'ang'a Kariga

This Thesis has been submitted for examination with my approval as the University Supervisor.

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DR. E.M. IRANDU

DEDICATION

This Thesis is dedicated to my parents who have contributed

significantly to see me through my education aspirations.

ABSTRACT

In the rural areas of Kenya, the nature of roads is identified as, but one of a number of interrelated constraints to development. In these areas, the cost of transport is a significant factor affecting agricultural development and modernisation. This study generally focuses on the economic impacts of rural infrastructure narrowly defined as roads.

The primary objective of this study is therefore to identify, describe and analyse some of the economic impacts of the feeder roads in the rural economy of Thika district. The economic impacts of the feeder roads are examined by investigating their influences on non-farm economic activities, horticultural land use and on farm gate prices.

Four major hypotheses were formulated and their validity tested using primary and secondary data collected. These are:

(1)   There is no significant relationship between proximity of household farms to feeder roads and the farm gate prices of french beans.

(2)   There is no significant relationship between accessibility of household farms to feeder roads and proportion of land used for commercial horticultural farming.

(3)   There is no significant relationship between prices of agricultural commodities in retail markets and the accessibility of these markets.

(4)   Rural roads do not significantly influence the size and

        location of non-farm economic activities in the rural

        areas.

Qualitative and quantitative analyses are used in the study to establish essential

facts, perform test of hypotheses and enable relevant conclusion(s) to be drawn.

Initially a comprehensive literature review is attempted with the purpose of extracting

essential information from available secondary sources.

The major findings of this study were that rural feeder roads influences significantly

the farm gate prices of agricultural commodities, horticultural land use and the

locations of non farm economic activities in the rural economy.

The significant contribution of this study is in the area of rural development planning

in Kenya. The study empirically shows that rural roads have an important role to

play in the development of these areas, given that they positively

influence some parameters of growth and development in the rural economy.

The study recommends that planners and policy makers in the government, should

lay more emphasis in rural infrastructure to ensure rapid development in these

areas. The study also recommend further studies to be undertaken in other rural

areas of Kenya to determine how rural infrastructure affects the growth and

development of these areas.

ACKNOWLEDGEMENTS

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INTRODUCTION

1.0 STATEMENT OF THE RESEARCH PROBLEM

Geographers have long been concerned with the spatial organization of development. In the recent past, a significant re-assessment of the role of transport in the development of the Third World Nations has been taking place. This has been motivated in part by the concern over the spatial and personal maldistribution of income and inequity in delivering basic needs to these dominantly rural Nations (Leinbach, 1987).

It is well documented that inefficient rural transport perpetuates subsistence agriculture and stalls progress of the transformation and integration of the rural sector. Along with this, it has been shown that transport is critically interwoven with communication and social change. Howe (1983), contends that just as commodities flow over the links of a network so too do ideas and information. It is further recognised among development specialist and planners that transport has and will continue to play a critical role in development. This function is viewed mainly as supportive that is necessary but not sufficient inter-actor with development.

Despite the importance of transport in regional and national development, there is very little known about the ways in which transport investment should be applied and carried out, who benefits and the real impact of the investment (Howe, 1983). The appropriate role for infrastructure particularly rural road transport in the

economic development of Third World Nations has therefore remained a largely un-explained and underrated issue (Ahmed, 1990).

One of the most critical problems in the spatial organization of development especially now in the era of economic liberalization is the tendency for extreme polarity of investment flow towards well established core regional centres. The imbalance may be improved or prevented by altering the configuration of channels through which information, people and commodities are propelled. Such strategies of regional development must utilise the transportation system as a mechanism for the re-organization. However, before using the transportation networks for spatial organization, there is need to understand clearly the nature of its impact on economic development in our societies.

This study focuses mainly on the economic impacts of the feeder roads in the rural areas of Thika District. The study attempts to investigate the impacts of the rural road network on horticultural land use and the farm gate prices of French Beans, a major horticultural crop in the study area. The study also describes the spatial variation of prices for selected agricultural commodities in major retail markets in Thika district, in relation to accessibility. In investigating the influence of the rural roads on these two aspects, the study attempts to understand fully the inter-relationships between the farm unit (taken as the farm land and the farming household) and the road transport in the study area.

The study also examines the relationship between road density and the proportion of land under high value crops in the study area and also agricultural

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land use in relation to road density.

The study further attempts to identify, analyze and describe the impacts of the rural feeder roads on the location and growth of the non farm economic activities along these roads and in selected rural, trading and market centres within the study area.

This study, therefore, attempts to address three broad questions. These are:

1.   What is the impact of rural feeder roads on the farm gate prices of agricultural commodities in the household farm? Is there any relationship between accessibility of household farms to feeder roads and the farm gate prices of french beans sold? Does accessibility of retail markets in the study area affect the spatial variation in prices of agricultural commodities?

2.   To what extent do rural feeder roads influence agricultural farming practice system or land use in the rural areas? Is there any relationship between household farm proximity to feeder roads and the levels of horticultural farming activity in the study area? Does the road density influence the proportion of land under high value crops in the study area ?

3.   What is the impact of rural roads on the location and growth of non-farm economic activities. Do rural trading and market centres located at places of varying degrees of accessibility along these roads have differences in their sizes and structure of non farm economic activities?

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1.1 LITERATURE REVIEW

1.1.1 Introduction

The main objective of this section is to identify gaps in what has already been done on the impacts of rural road transport. It also endeavors to identify key questions which may not have been adequately answered. The literature review is also necessary for purposes of extracting essential information from empirical studies already undertaken.

In order to review the literature effectively and in an organized and systematic manner, three major categories, namely theoretical literature, transport and theories of location and empirical literature are discussed. Under general theoretical literature we consider the major approaches in the study of transport geography. In the section on transport and theories of location we will highlight the major theories explaining the role of transport in location of economic activities. Finally, we turn to a review of the empirical studies on the impacts of transport network on general economic development.

1.1.2 Theoretical Bases

(a)   General Theoretical consideration in transportation Geography

The literature in transportation geography before 1950s reveals of a discipline that was not fully developed. The discipline was descriptive and regional based. In this period, studies in transportation geography focused mainly on describing the lay out of transport networks in terms of location and classification. According to Hurst

(1973) the transport literature revealed a difference in approach between two set of Geographers: Geographers in North America and Geographers in Europe Geographers in North America were largely pre-occupied with route classification. descriptive mapping of route location and flows. On the other hand, Geographers in Europe focused on modes of transportation and commodities carried.

The earliest attempt to establish a broad base for a theoretical approach to the study of transportation Geography was by Ullman (1956). He laid down a three factor typology to explain conditions affecting transportation development. Ullman identified three concepts that form the basis for spatial interaction. These three concepts include complementarity, transferability and intervening opportunity. Because of the significance of Ullman's theory in interaction studies, an exposition of these three concepts is necessary.

According to Ullman, complementarity is the first factor in an interaction system because it makes it possible for the establishment of routes. Complementarity is a function of both natural, cultural areal differentiation and of areal differentiation based simply on operation of economies of scale (Ullman, 1956). For two places to interact there must be a demand in one place and a supply at another, and the demand and supply must be specifically complementary.

An intervening opportunity as a base for spatial interaction may be considered and viewed as a spatial sponge that soaks the potential for spatial interaction between two complementary areas or regions. Ullman identified an

intervening opportunity as that which can inhibit interaction between the two areas when demand is met by a third area.

A third factor required in an interaction system is distance measured in real terms of time and money costs. When distance between demand and supply area are too great to overcome no interaction will take place. The concept of transferability is often used to refer to distance between these two places.

For spatial interaction to occur between two areas, the distance between them must be such as to allow friction of distance to be overcome. If the time and money costs of traversing a distance are too great, the movement will not take place despite perfect complementarity and the absence of intervening opportunities. Transferability differs between places, classes of movements and between modes of movement.

Ullman's simplistic conception of the bases of spatial interaction has various limitations. It involves a deterministic framework where movement is always considered to the nearest. Furthermore the basis of interaction system proposed by Ullman applies primarily to interaction based on physical movement of goods and people (Hurst, 1973).

Wheeler (1978) devised a theoretical framework for the study of transport Geography. He emphasized three research frontiers which are interrelated and focus on:

1.   Networks, their location, structure and evolution.

2.   Flows on networks.

3.   The significance and impacts of networks and flows on space

Wheeler asserts that studies based on the above seek to develop a set of principles of networks' interdependence with the economy showing how changes in accessibility for example can trigger nodal growth or decline. The study frontiers highlighted above by Wheeler are detailed for they pay more attention to the wider socio-economic system.

Abler, Adams and Gould (1978) stress five areas of study in transportation geography. These are:

1.   Transportation development in relation to Ulimans' three factor theory of spatial interaction.

2.   Types and causes of movement as embodied in migration, trade and diffusion.

3.   Area specialization studied through input- output analysis.

4.   Interaction theory as expressed by gravity and potential model.

5.   Analysis of transportation system using techniques of movement geometry, network analysis and flow analysis.

In their effort to lay a theoretical framework for the study of transportation geography, Rimmer (1971), Hurst (1974) have suggested an analysis which includes inter-connections between transport system and the socio-economic development of a given region.

In summary the fore-going discussion shows that transportation is an

agency by which every society is brought into relation with every other and interdependence, specialization and organization made possible. Transportation is therefore the physical bases of and the instrument of social organization in a society. The relation and connection between areas are reflected in the character of transportation facilities in the flow of traffic. This underlines the crucial role of transportation in a society.

(b) Transport and Theories of Location

It is widely recognised that the pattern of economic activities in space is not even. For instance, in some areas agriculture is intensive and there is specialization in the production of high value fruit and vegetable crops, while in others it is extensive specializing in grain crops. Service activities such as whole sailing and banking are also often highly concentrated.

The factors underlying these variations in the distribution of economic activity are numerous. Among them transport is important.

In trying to develop theories to explain patterns of location, geographers have had to take account of transport as a factor. In 1826 Von Thunen published his book, The Isolated State. His theory are well known to Geographers and has been fully incorporated in various models developed by geographers (Chisholm 1962, Tarrant, 1974).

Von Thunen's land use model of agricultural location activity consists of concentric rings of land use around the central isolated city. The rings resulted

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from increasing distance and therefore increasing transport costs. Von Thunen postulates a flat plain isotropic with uniform soil conditions and all produce being transported by horse-drawn carts along radial roads into the city. Thus, any point equidistant from the city will have equal production costs, lower than places farther out and higher than places farther in. But any improvement in transport facilities along any radial route for example a navigable river will reduce transport costs from any point on the radial route below those of any point at similar distance along any other radial. This will tend to elongate the land use zones along the line of improved transport.

Afred Weber, writing in 1909 argued that industrial location was largely a matter of transport costs and that the best location is one which minimizes transport costs and therefore total costs. Weber has been criticized as emphasizing the importance of transport costs at the expense of other costs making up total costs.

Hoover (1948) developed Weber's arguments and suggested that total transfer costs of which transport costs are a major element are basic to location theory. However, many recent writers Chisholm (1970) among them point out that other factors are also important in determining the location of economic activities.

(C) Theory Linking transport to Development

The theory linking transport influences to economic and social change is poorly developed and available theories are very general. The search continues for

meaningful generalization and principles to incorporate into a unified theory (Howe, 1984 pp. 51). The present study hypothesises a linkage between transport networks and economic development. Present theories emphasize three causal possibilities in relation to transport provision. According to storey (1969) these are:

1. A positive effect where new directly productive activities are the direct result of providing transport facilities.

2. A neutral effect where the provision of transport facilities do not themselves call forth directly productive activities and subsequent increase in the level of economic growth.

3. A negative effect where transport facilities eliminate directly productive activities and effectively reduce the level of economic growth as for example, Where over ambitious and prestigious efforts to create a national highway system divert investment from efficient uses.

These categories are however not very useful since the conditions associated with each one of them is certainly not sufficiently well known to avoid the occurrence of the other (Howe 1984, pp. 52).

In their well known paper on transport expansion in underdeveloped countries, Taaffe, Morril and Gould (1963) discussed the evolution of transport development in underdeveloped countries and proposed a model for the analysis of such patterns. This model is based on six distinct stages in the sequence of transport development. This model is shown in fig.1.1. The main stages as presented in the model are: Scattered ports, beginning of interconnection.

penetration lines and port concentration development of feeders, beginning of interconnection, complete interconnection and emergence of high priority main streets. This ideal typical sequence of transport development has been applied for instance by Hoyle (1973) in the analysis of transport development in East Africa. Ogonda (1986) in his study of the development of road network in Kenya has also compared this development to the model highlighted above. The model has been found wanting in explaining the pattern of transport development in various countries. The model is however particularly useful in examining historical evolution of transport networks and is of little help in impact studies of transport network.

Owen (1964) writing on the strategy for mobility has indicated that transport is clearly a necessary ingredient of nearly every aspect of economic and social development. Emphasizing on the role of transport in development Owen notes: "....it plays a key role in getting land into production, in marketing agricultural commodities and in making forest and mineral wealth accessible. It is a significant factor in the development of industry, in the expansion of trade, in the conduct of health and in exchange of ideas".

Taaffe and Gauthier (1973) provide a detailed schema for the study of the impacts of networks of transport and the flows on the development function in the space economy. Their schema is also useful in examining the locational structure and evolution of networks.
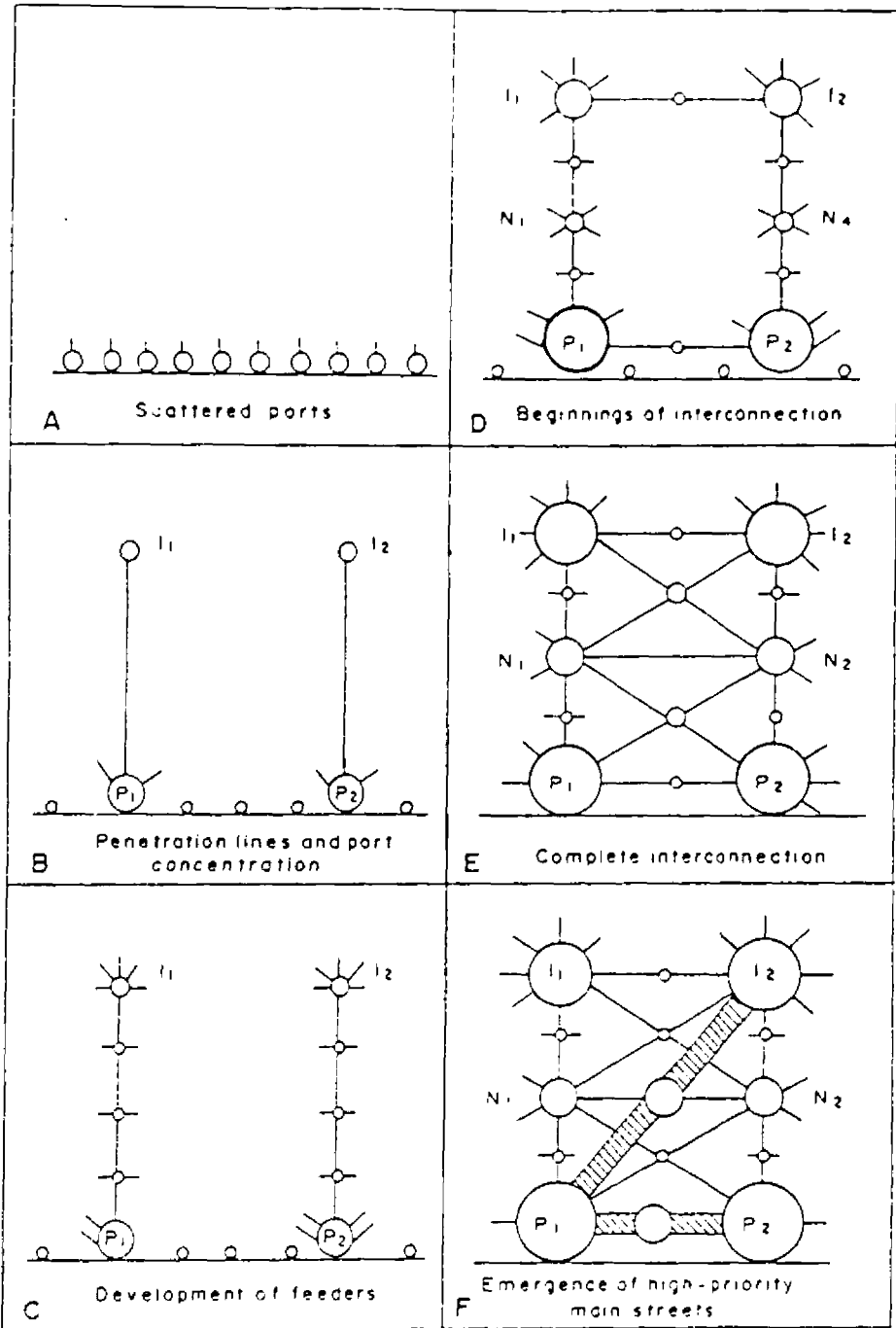
Figure 1.1 Ideal-typical sequence of transport development
Source : Taaffe, E.J. Morrit, R.L. and Gould, P.R. 1963 pp 504.

A — Scattered ports

B — Penetration lines and port concentration

C — Development of feeders

D — Beginnings of interconnection

E — Complete interconnection

F — Emergence of high-priority main streets

Summary on the Theory Linking Transport to Economic Development

In the early years of independence many developing countries took for granted that the provision of transport infrastructure would automatically lead to the consequent economic and social development (White, 1980). It is to be noted that transport investments may indeed have a negative impact on the economic development of a given area. The idea that transport investment is a necessary condition for achieving overall economic development should be treated with care.

In practice, as revealed by empirical studies that follow, transport infrastructure is only a necessary condition for development to take place. Investment in other projects may be necessary. The argument that transport may fail to fulfil its development functions is based on several factors. One, it could be inadequate. Two the area through which it passes may be incapable of development and three, the costs of using it might be too high.

1.1.3 Empirical Bases

(a) Studies Conducted Outside Kenya

There is a wide range of empirical literature material focusing on the impacts of road transport on socio-economic development. Most of these studies have been conducted by economists, majority of whom have tended to ignore spatial variables. There is also a considerable number of case studies undertaken by Geographers. It is these latter studies that are of more interests to the present study. Let us now consider a review of these studies and where possible we also

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highlight the methodology adopted in the study and the weakness of the studies.

One of the earliest known studies on the impact of road investments was by Smith (1959). His study was primarily concerned with the impacts upon economic development of feeder roads in West Nile District of Uganda between the period 1948-1956. The study was based in two regions with different road transport network characteristics. In one region feeder road construction had taken place while in the other no roads had been built.

Smith's study confined its investigation to measuring the rise in volume and value of cotton production. This was related to road density in each of the region under study. The result and findings of this study which were based on data for a three year period indicated that income from cotton in those regions where road had been constructed increased by between 100-200 percent relative to those regions without new roads.

A statistical control was attempted in this study for it was possible to observe the effects of road in an isolated way by comparing the impacts of the roads in areas where road had been built and the areas where no road had been built at all. This study was basically concerned with investigating the impacts of the road on agricultural production. The study found conclusive evidence suggesting a positive relationship between road provision and agricultural production. Smith's study is out of date and has various limitation. The study focused on impacts of the road on the agricultural sector alone. No effort was made to assess the impact of the roads on non farm economic activities. The

present study considers the impacts of the rural roads on non farm economic activities among other things

In another related study done by Jittasatra (1967), to investigate the economic impacts of feeder roads upon agricultural production in Thailand it was found that improvement of the feeder roads resulted in a rise in agricultural production. The objective of this study was specifically to examine the impacts of the feeder roads on rice and vegetable production. The study found that rice production was altered slightly while the production of vegetables in villages close to market towns increased in response to the road investment.

The research study further examined why the increase in rice and vegetable production occurred in only those areas close to the feeder roads. An attempt was made to relate the increases in vegetable and rice production to accessibility to market centres and road facilities. Proximity to a specific road was used as an index of accessibility and linear regression technique was employed to analyze the village level data collected. It was found that vegetable and rice production per unit area was more in household farms located close to the feeder roads . The · study concluded that the development impacts of the road facility on the farming community was greatly influenced by the proximity of the households farms to the road facilities. The methodology adopted in this study analyzed the impacts of the road within the framework of distances of the households from the roads.

Bonney's (1964) study on the relationship between provision of road, economic and social development in Sabah in India focused on the effects of road

on export crop production. In the area of study roads had been built to ease the work of administration in the region and for opening up land for settlement.

Linear correlation analysis was used in this study to analyze the data collected on new acres of export crop cultivation in relation to distance from the road. The study found a direct relationship between new acres of export crop cultivation and the standard of road and distance from the main commercial centres.

Although the available data did not permit the quantification of social factors the author noted that development of an active exchange economy depended to a considerable extent on the transportation means. In this study no investigation was made on the relationship between accessibility of household farms and the farming practice systems.

The work done by Wilson (1965) on the effects of highway construction on development in United States found similar results to those of Smith (1959) study in Uganda. Wilson reported that there had been a rise in traffic along the new highway roads representing a net increase in total mobility. According to Wilson the greater mobility also represented a net increase in physical output as well as higher value of output per unit of weight of good produced.

Substitution for low valued cash crops and subsistence crops was observed to take place. Wilson found that the mechanism that served to stimulate additional output cultivation of new land and more passengers travel was the sharp decrease in freight and passengers charges and the improved service.

In a related study on the impact of a highway on agricultural production in Argentina, Miller (1968) attempted to estimate the increase in agricultural production which could be attributed to highway improvement. The study was based on an analysis of farm production and marketing costs as well as on interviews with producers and transporters. Miller concluded that it was not certain whether road improvements possessed the catalytic quality associated with road construction. In this study Miller found that for producers to benefit from road improvement gains from the road improvement must be received first by trucking enterprises then passed to marketing intermediaries and finally transferred to farmers. According to Millers' study the farmers failed to benefit from the roads because the savings accruing to the trucking enterprises were not passed to them.

In another study sponsored by the World Bank and conducted by Van der Tak and De Well (1969) to evaluate the impact of trunk road network in Iran, the authors noted: "... The road network in Iran was expected to have substantial development benefits, Unfortunately we found little clear evidence that such benefits materialized".

The authors concluded that with monopolistic marketing conditions prevalent in Iran it was not possible for benefits in transport cost savings to be passed to producers and farmers. This finding is consistent with other findings from similar studies that indicate transport investment is only a necessary condition for development to take place rather than a sufficient condition.

The study by Ward (1967) in Papua New Guinea has relevant and

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interesting findings for the present study. Ward's study objective was to examine the socio-economic impacts of a certain feeder road in Papua New Guinea. He observed that the feeder roads had stimulated village market gardening. New estate for production of rubber, small scale poultry farming and cultivation of European vegetables. In this study, the feeder road investigated connected a potentially productive hinterland direct to the capital. The study was based on primary data collected through administration of questionnaires. A wide range of data on socio-economic of the household including distance to a feeder road, crops grown etc, was collected.

Linear correlation analysis and simple linear regression techniques were used to analyze the household level data collected. It was found that proximity of household farm to feeder road was a major factor determining the nature of economic activities among the household farms studied.

Bouchard (1972) conducted a study on the impact of feeder roads in the Okapa region of Papua New Guinea. This study sought to examine the impact of the rural roads on agricultural productivity. The study results indicated that there was very little change that occurred in agricultural production after the roads had been constructed in the area. An analysis was made on the relationship between accessibility defined in terms of the costs of the transport and income from cash crop (coffee) and new monetary income entering village economies from the cash crop income and casual employment. The study found that the cash crop income was not related to accessibility and this was due to the fact that farm-gate prices

for coffee were uniform throughout the area. The coffee buyers gathered all the coffee on all the roads that were trafficable regardless of the distance from the main centre. A positive relationship was however found between total income and accessibility. This was largely due to inclusion of income from casual employment which was dependent on proximity to urban centres. This study is relevant to the present study for it considered the relationship between accessibility and the farm gate prices of an agricultural commodity.

A study conducted and published by the local government in Philippines in 1978 to evaluate the economic impacts of rural roads has relevant findings for the present study. The study Was based on six different locations along the rural roads. The study found considerable improvements by a range of economic, social and human service indicators which were attributed to the feeder roads. This study was based on different feeder roads ranging in length from 4-9 kms. and was conducted two years after the completion of the road construction. The main economic impacts of the road that were reported in this study were an increase in gross household income by 28 percent and for non farm income by 20 percent. These increase was attributed primarily to reliable transport, cheaper farm inputs, higher farm-gate prices and a large share of major crops sold directly in the markets. Other social benefits attributed to the improvement in roads were an increase in non farm employment in road side activities, better access to education, health and improved recreational facilities. The study relied on primary sources of data especially data obtained from household interviews. The

methodology adopted in this study is relevant to the approach adopted in this study, where the impacts of the feeder roads are analyzed within the framework of distances of the household from the road.

Riverson and Hine (1979) study is important and relevant for the present study in that it specifically examined the impacts of the feeder roads on agricultural farming system. The primary objective of the study was to determine how some selected parameters of rural development in Ghana namely, costs, prices and agricultural practices varied with accessibility. It was found that agricultural farming practices were not affected by accessibility. According to the results of the study the more in-accessible villages in the study area concentrated on agriculture to a greater extent than the accessible villages. The more accessible villages on the other hand were able to use advantage of their position to concentrate their efforts on non agricultural activities such as marketing, rural industry and the provision of other services. Accessibility of villages was also shown to positively influence the level of passenger trips made. The Accessibility of the villages was measured by their proximity to a paved feeder road. Data on these variables was obtained from topographical maps. More data was also collected on a wide range of socio-economic variables namely prices, costs, crop output, size of land and the proportion of cultivated land. This data was collected through a social survey made in the area of study. The collected data was analyzed by correlation and regression analysis techniques.

Bansal and Patil (1979) carried a study on the socio-economic impact of

roads on village development in India. The study was based on survey data and other data from a random sample of 1662 villages in India. Details of changes in a range of village characteristics were obtained for the period 1961 - 1971. The main variable accessibility was measured as an index constructed to reflect both distance and road quality. Correlation analysis, multiple regression and discriminant analysis, were used to isolate the effect of changes in accessibility on a range of socio-economic variables.

The study found that the effects of accessibility was greater for un-improved roads than for improved roads. This indicated that in bringing about socio-economic development the existence of some kind of trafficable road was of major importance. The study further revealed that rural roads have an impact on agricultural development as well as on rural development.

Recent research conducted in Bangladesh found that in villages with better infrastructure, fertilizer costs were 14 percent lower and wages were 12 percent higher (Ahmed, 1990. IFPRI). The objectives of this study was to empirically investigate how rural infrastructure affects the growth of income and alleviation of poverty in rural household economies.

Field data were collected from about 640 households through five Questionnaires administered during a specific period in a year. Based on the data from this survey, a common index was constructed for all elements which was used to rank villages according to their degree of infrastructure development, villages evaluated by their access to transport, markets, modern inputs, electricity

and social services were divided into two groups developed and underdeveloped. According to the result of this study rural infrastructure development increases the speed of diffusion of agricultural technology, reduces the cost of marketing and improves the operation of both input and product markets, through improved linkages with other sectors. Ahmed (1990) indicates that similar findings would be likely for most countries in sub-saharan Africa. However, studies to substantiate this claim remain, for the most part underrated.

A study conducted recently by Rawat and Sharma (1997) focused on development of a road network and its impact on the growth of infrastructure. This study was based in Almora District in Central Himalaya in India. The objective of this study was to empirically analyze the relationship between extension of basic facilities in the rural landscape with the road network.

A three step methodology was adopted. First the physical setting was mapped on a scale of 1:50,000 based on survey of Indian Topo- sheets, second data on developments were collected from district level offices such as District statistics office, District agricultural office and public works office.

Third, maps were prepared based on the physical maps with inputs from the field survey and other accumulated data. The impact of the roads on development was analyzed in the framework of three zones based on distances from the road. The first zone was where the infrastructure developments were located on a road or within 2 Km distance. The second zone between 2-5 Km and the third zone was more than 5 Km from the road.

The study found that infrastructure was concentrated along a road or within a distance of 2 Km and declined with increasing distance from the road. The distribution of primary education schools and postal services was not influenced by road network but the impact of the road was clearly visible. The study revealed that major human and animal health care facilities were concentrated at a few easily accessible points and the location of other facilities was determined by distance from the road. The study further indicated that drinking water supplied by Government agencies and electricity network were initially introduced along the road network. This study concluded that a road network is the most felt need for economic development in areas with poor and inadequate accessibility.

(b) Empirical Research Studies in Kenya

In Kenya the study by Birdsall (1968) in Western Kenya is among the earliest studies on the impacts of roads on agricultural development. Birdsall study was concerned with justification for decision concerning economic development investments. The main objective of Birdsall study was to determine where the most remunerative investment in roads should be made. The study therefore focused on the problem of investment in agricultural feeder roads.

Birdsall's study indicated that agricultural production responded positively to improved road network. He maintained that farmers responded first to and benefitted from lower transport costs. He further found that roads encouraged change in farmers perspective in a manner which was conducive in altering

farming methods by allowing farmers to market surplus produce to the markets located along transport routes.

In his findings, Birdsall notes: "... one of the more immediate results of increased efficiency appears to be a rise in agricultural production within the area through which the route passes, although such cause-effect relationships are impossible to determine with certainty (Birdsall 1968 p.83)".

Kinyanjui (1976) examined the impact of a new road constructed through the hinterland on the Western side of Nairobi city. He found that the road had led to rapid urbanization of the hinterland in form of extended urban sprawl. The study was primarily concerned with the impact of the road on urbanization process. However, the study did not cover the influence of the road on the non-farm sector, rather it was mainly concerned with the impacts of the road on urban growth and development.

Madunga (1975) made studies relating to transportation in two different case study areas. One of the case study areas was in Uganda, while the other was in Kenya. The aspects Madunga considered for his two study areas were many and varied. Although agriculture was one of them, there was no attempt made to examine the influence of the roads on agricultural land use.

Alela's (1976) study on the role of transportation in rural development of Kakamega district is also worth highlighting. This study was basically concerned with a holistic approach of the contribution of roads to general rural development. Alela's study lack detailed consideration of specific aspects of the influence of the

roads in the rural economy that are considered in this study.

In a related study to that of Kinyanjui (1976), Kariuki (1977) conducted a study on the impact of the Nairobi-Thika highway on land values, settlement and land use patterns. The study found that the highway was a major force behind the increase in land rent and land values in the rural-urban fringe. This was particularly so on the area adjoining the highway. By use of descriptive statistics to analyze the data collected on the impact of the highway on land values, it was found that accessibility was a critical factor in the rural-urban fringe development. It was reported that accessibility triggered urban sprawl along the road. A conclusion was made to the effect that the influence of accessibility on areas around the highway was important in explaining changes in land values and settlement patterns.

In another study conducted by Obiero (1978) on the role of feeder and access roads in agricultural production and planning in Busia District of Kenya, it was found that rural access and feeder roads played an important role in rural development. The main objective of this study was to examine how lack of or presence of access and feeder roads affected rural development over time and space. By use of simple Linear regression analysis on the data collected the study found that rural access and feeder roads positively influenced agricultural production and hence development of the rural areas. Obiero recommended by way of design for the construction of more feeder roads to serve the relatively dense population especially in high potential agricultural regions in the district.

The study by Obiero though focusing on the influence of rural access and feeder roads on agricultural development made no attempt to examine the impact of the roads on the farming practices and the non farm economic activities. Furthermore the study generalized that the benefits of the rural access and feeder roads were spatially distributed to cater for all the population. This study was mainly concerned with the planning aspects of rural access and feeder roads in terms of construction priority and linkage aspects.

In his study on the growth and development of road transport network in Kenya, Ogonda (1986) sought to examine the impacts of the road transport network on the overall pattern of development. He used composite measures of socio- economic development and found that transport networks influence the level of development. This was arrived at by the use of stepwise regression analysis where transport index was used separately as an independent variable for explaining the levels of development. It was found that the districts with higher scores on the index of road transport tended to score highly on other indices of development.

In the analysis it was found that the more developed districts were concentrated in Western, Nyanza and Central province. The major differentiating elements in the level of development were identified as population sizes and densities in the districts, the pre-dominant type of agricultural practices and access to closer networks of transportation routes. The result of the stepwise regression showed that the indices of transport, education and health explained 99 per cent of

the variation in development in Kenya. The key element factor was found to be road transport.

On similar analysis using the index of transport as the dependent variable Ogonda found that the indices of population, agriculture, industry and commerce accounted for 75 percent of the total variation with population index being the most important element. It was concluded that transport and development relationship is a two way interaction process.

The study by Ogonda was a general macro analysis of the role of transport in economic development in Kenya, rather than an impact study of the transport network. The study emphasized on the historical development and growth of the road transport networks to specific indicators of growth in the economy. In short Ogonda's study was concerned with historical patterns of the development of road networks in Kenya and its impact on the pattern of development. The present study is mainly concerned with the impacts of the rural feeder roads. More specifically this study is a micro investigation study on the economic impacts of the feeder road in rural areas of Thika District. Being a micro analysis this study seek to understand more the relationship between the farm unit (taken as the farm land and the farming household) and the road transport system at the local levels.

Kimani (1990) examined the impacts of rural access roads program on agricultural development in Ol-Kalou division in Nyandarua district of Kenya. He found a positive influence of the roads on agricultural production. The study used simple linear regression analysis to analyze the data collected on agricultural

production in selected villages in the division. The study found conclusive evidence indicating that agricultural intensification had taken place after the construction of access roads. The study reported that dairy farmers were able to sell the milk produce more conveniently as a result of opening up the villages through the construction of the roads. It was also reported that obstacles in transportation system during wet season adversely affected agricultural production in the area. However, his study did not attempt to evaluate the influence of the roads on farm-gate prices of agricultural commodities in the area. Furthermore no attempt was made to assess the impact of these roads on the non farm sector in the rural areas.

In a study on the role of roads in poverty alleviation in Baringo District of Kenya, Odero (1992) has shown that there is a positive relationship between provision of all weather rural access roads and poverty alleviation. He indicated that accessibility of rural areas to urban market centres provided farmers with opportunity to produce and sell surplus produce from the agricultural sector. The study further found that provision of all weather rural roads aided in the transformation of the rural production systems from subsistence agricultural systems to commercial cash crop farming. This study however did not consider the role of rural roads in influencing specific types of agricultural land use and the non farm sector in the rural areas of the district.

In a study of the air transport in Kenya, Irandu (1995) has shown that air transport and road transport are among the most important factors that influence

the spatial pattern of development in Kenya. In order to determine the strength of the relationship between the pattern of development with air transport. bivariate and multiple regression and correlation analysis were employed.

In the composite index of development that he developed to explain the pattern of overall development in all district in Kenya an indicator of air transport and road transport were included. The road transport variable accounted for 2.9 percent of the total variation in the composite index of development status. while air transport variable accounted for 13.1 percent of the variation.

In this study the main focus was a detailed study of air transport though road transport was considered in the computation of composite index of development. The result of this study indicates the important role of both road and air transport in the overall spatial pattern of development.

The present study intends to examine at micro level some of the impacts and influences of rural roads in the rural economy. This is intended to contribute valuable knowledge on the developmental impacts of rural road infrastructure in the rural economies of our country.

1.2 JUSTIFICATION OF THE STUDY

This study focuses on rural road transport which is a major concern for Economic Geographers. Geographers should be concerned with the study of transport for two main reasons. First. transport is a significant human activity with a strong spatial component and is therefore a legitimate object of study in its own right as

much as agriculture or retailing. Secondly, it is an important factor influencing the spatial variation in many other social and economic activities.

The present study, therefore, empirically addresses the issue in the neglected area of research on how rural feeder roads affect the growth and development of the rural economy. This study, therefore intends to fill research gaps in this subject given that no similar studies of this nature have been undertaken in the study area in the recent past.

It should also be noted that the chief importance of transport arises from its role as one of the principal factors affecting the location, distribution, growth and development of economic and social activities. Despite this general awareness, there is very little known in Kenya, about how benefits arising from investments in rural roads vary in space and how they affect the rural economies. It is therefore appropriate to examine some of the economic impacts of the feeder roads in the rural areas of Kenya to understand how they spatially influence certain growth indicators in the rural economy.

Studies so far conducted in Kenya on the impact of the road transport network on economic development have for the most part tended to focus on urban areas (Ogonda, 1976; Irandu, 1982). This bias towards urban areas has seen a general neglect of the rural areas in academic research aspiration.

In rural areas of Kenya, where agriculture is the main economic activity, the greatest need in raising income to farmers is to facilitate mobilization and marketing of surpluses from the agricultural sector and ensuring fair prices to

farmers. This will increase agricultural production and hence raise income to the farmers and thereby help to alleviate poverty. In order to achieve these objectives transport network must be used and it is necessary to have an understanding of how road transport influences marketing of agricultural commodities and their prices. The present study is an effort towards that direction as it attempts to evaluate the influences of feeder roads on farm gate prices.

The interest in this study especially the aspects pertaining to the impacts of rural roads on farm gate prices of agricultural commodities has been inspired by the author's own observations. This includes a significant lack of uniformity in farm gate prices of agricultural commodities in the study area. This has been more so, in the case of horticultural crops, produced for export in the area of study. The non-uniformity of farm gate prices of agricultural commodities in the area of study has also been of major concern to the farmers in the area, who are left wondering on the causes of these variations. This study therefore attempts to relate the farm gate prices of French beans to the road facilities.

There is a growing interest today in the topic of non-farm economic activity such as small scale industries located in rural areas of Third World (Wanmali, 1991) These activities are viewed as a means of alleviating rural poverty and reducing inequality in poor and densely populated agricultural areas. It is therefore, necessary to examine the impacts and influences of rural roads networks on the structure of non-farm economic activities especially in rural market centres. This will assist in designing good rural development planning policies for

the improvement of these important economic activities.

The Eighth National Development Plan (1997-2001) indicates that as of 1994 an estimated 42 percent of the rural population lived below the poverty line. The Development Plan has projected that this figure will increase tremendously during the plan period. The main problem facing rural population in our country should therefore be seen as that of alleviating mass poverty. This study attempts to establish the extent to which farm gate prices of agricultural commodities in the study area are influenced by proximity of household farm to the main feeder road. The results of this study are expected to be useful in contributing necessary information in the formulation and designing of rural development planning policies aimed at reducing the rampant mass poverty.

It is further noted that remunerative output prices accelerate the pace of agricultural intensification and production if effectively transmitted to the farmer. The extent to which villages and households farms accessibility to roads influences agricultural commodity prices is worth investigating and studying in view of the above.

The present study is especially appropriate for Thika District since there are many weather roads but few that are efficient for transport. Also agriculture is the most important activity in the region.

Most of the households are therefore engaged in small scale farming hence marketing of their farm produce and distribution of farm inputs are crucial to their farm activities. The condition of the road network and marketing infrastructural

facilities are crucial for their success. A study of the economic impacts of the rural roads on the rural economies in the area of study is therefore relevant in transformation and spatial re-organization of the area within the integrated National development program. Since the nature of the roads in Thika District is identified as but one of a number of interrelated constraint to development it would be of interest to investigate this claim through a scientific research.

Given the scarcity of land in the face of a growing population off-farm employment opportunities such as in coffee industries, commercial trade and other type of "Jua Kali" activities are of vital importance to the rural population. This study intends to determine the relationship between accessibility of rural trading and market centres on the one hand and the structure of non farm economic activities in these centres. Furthermore the study also seeks to establish the influence of the rural roads on the location growth and development of road- side non farm economic activities.

In rural areas of Kenya as is else where in many other developing countries, where the potential for labour absorption in agriculture is believed to be limited non farm activities should be viewed as a means of achieving several policy objectives. Such objectives include alleviating poverty, reducing income inequality, increasing employment, slowing down rural-urban migration, reviving crafts and building small scale industries using local resources. It is therefore necessary to examine the impacts and influences of rural road network on this important sector. The findings whether favourable or otherwise will be useful in designing rural

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1.3 OBJECTIVES OF THE STUDY

The primary objectives of the study was to identify, describe and analyze some of the economic impacts of rural feeder roads in Thika District. The focus was mainly on small scale household economies in the rural areas of the district. It is clear from the above objectives that the emphasis of the study was on benefits of rural feeder roads. This is appropriate because it is the benefits of rural feeder roads that are imperfectly known and often a source of controversy on resource allocation.

The specific objectives of the study are:

(i) To establish the relationship between accessibility of households farms to the feeder roads and the farm gate prices of French Beans.

(ii) To establish to what extent prices of agricultural commodities vary in the major retail markets in the study area in relation to their accessibility.

(iii) To determine the relationship between accessibility of households' farms to a selected feeder road and proportion of land used for commercial horticultural farming.

(iv) To relate general agricultural land-use in the study area to the road network.

(v) To determine the impacts of rural feeder roads on the location and growth of selected non-farm economic activities along these roads in the study area.

(vi)   To establish the relationship between accessibility of selected rural trading and market centres on the one hand and the structure of non-farm economic activities in these centres.

1.4   THE SCOPE AND LIMITS OF THE STUDY.4   THE SCOPE AND LIMITS OF THE STUDY

The study covers the newly created Thika District which was carved from Muranga and Kiambu Districts in 1994. It examines some economic impacts of the rural feeder roads on selected growth indicators in the rural household economy. The focus of this study was primarily on small household economies. The study did not therefore capture in detail the impacts of the feeder roads on large household sectors such as corporate bodies which are dominant in Thika and Kakuzi divisions.

The indicators of growth in the rural economy used in this study such as farm gate prices of agricultural commodity, size of land under commercial horticultural farming and roadside business activities were assumed to be good surrogate measures of economic growth and development in the study area.

Due to lack of adequate finance and the numerous feeder roads only one feeder road was selected for detailed analysis of its impact on the household economies.

In an attempt to examine the relationship between accessibility of household farms to the feeder road and farm gate prices of French beans, the study was based on the middle agro-ecological zones of Thika district especially in

Gatanga division. This is where the crop whose farm gate prices were studied is grown on a wide scale by many small scale farmers. Furthermore, horticultural farming activity is widely practised in this region.

The selection of this zone was carefully done so that natural endowments such as soil, topography and water were evenly distributed. This was done to ensure that these agronomic factors did to influence significantly the relevant household data collected. Secondary data for this study was fragmented since the new Thika district was created recently. As a result most of the secondary data had to be gathered from Murang'a and Kiambu districts published materials. However, the available data was gathered from all the relevant areas constituting Thika district bearing in mind the new boundaries.

It must be mentioned that it was difficult to study the influences of the feeder roads on economic development. This was mainly due to the fact that the role of infrastructure is complex and its effects are indirect. Moreover, it was possible with the data collected to have a general overview of the impacts of the rural road infrastructure on farm gate prices of french beans, and its influence on horticultural land use. This was achieved through a methodology employing correlation, simple linear and multiple regression techniques, on the house wise level data collected.

Given the above limits, we are however satisfied that the study was successful and its objectives were realized.

1.5 HYPOTHESES

Four major null hypotheses were formulated and their validity tested using both primary and secondary data collected. The rejection of the null hypothesis led to the acceptance of the alternative hypothesis.

1. H_0:   There is no significant relationship between proximity of household farms to feeder roads and the farm gate prices of French Beans.

   H_1: Alternative

2. H_0:   There is no significant relationship between prices of agricultural commodities in retail markets and the accessibility of these markets.

   H_1:   Alternative

3. H_0: There is no significant relationship between accessibility of Households farms to feeder roads and the proportion of land used for commercial horticultural farming.

   H_1:   Alternative

4. H_0:   There is no significant relationship between accessibility of rural market centres and the size of non farm economic activities in these centres.

   H_1:   Alternative

1.6 CONCEPTUAL AND THEORETICAL FRAMEWORK

1.6.1 Operational Definitions

(a) Transport

The term transport as used in this study refers to the movement of goods and people.

(b) Economic Development

This term encompasses a series of qualitative and quantitative changes occurring in a given population whose effects over time are reflected in the standards of living of the people. The core elements of economic development involve raising people living standards

(c) Access roads

An access road in the rural areas is any road usually class D and E and in some cases class C which is for general movement of people and goods and connects nearly all important centres in the rural areas. Access roads are considered necessary for stimulation of development in the rural areas.

(d) Feeder Roads

Within the context of this study the kinds of roads referred to as feeder roads are those small rural roads that feed into main or trunk roads and tap the output of a productive area. These roads allow the transport of inputs and output in the rural areas. As the term suggest the roads feed back or facilitate the movement of goods and services between the area it serves and the main transport links. The figures below show the various types of feeder roads.

Fig. 1.1: Feeder Road
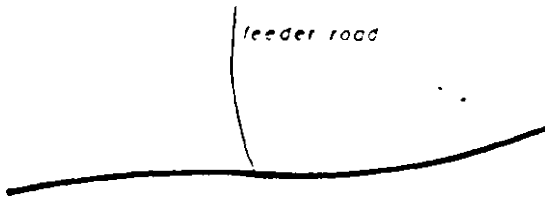
feeder road

A feeder road is a road that gives access to the bordering area and does not have a significant role as a network link for the use of through-traffic.

Fig. 1.2: Local Distributor Road

feeder

feeder

feeder

local distributor road
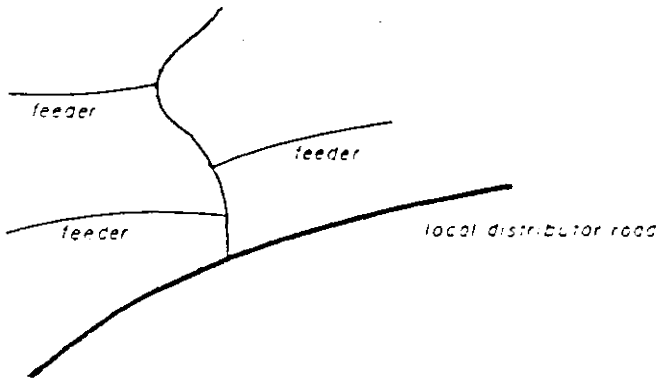
A local distributor road is partly a feeder road and partly a connector between the main network links and other feeder roads.

Fig 1.3: Secondary Road

feeder

feeder

feeder
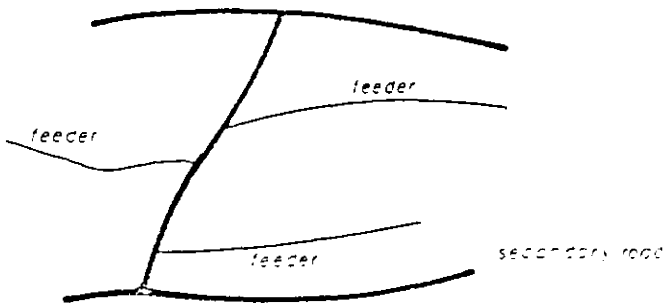
secondary road

A secondary road is an important link in the network carrying a significant proportion of through-traffic.

Source: Halcrow Fox and Associates. Road types: Fig 1. The Economic analysis of Rural Roads projects; World Bank Staff Working Paper No. 241, August 1976.

(e) Household

A household in this study refer to a family unit headed by either man or a woman with title to land ownership.

(f) Household Farm

The definition of a household farm as used in this study refers to the farming land or farm owned by a household, especially the small scale farmers among the farming community in the study area.

(g) Network

The lay out, geometry or pattern of the routes fall under the rubric of network. It also include analysis of the location of intersecting nodes and terminals, the density and length of routes and the accessibility of individual points on the network. These notions are related to the factors conditioning the development of transport.

(h) Accessibility

Accessibility is a measure of ease (time, cost distance or effort) in which transfer occurs between places and areas of a system. Accessibility can be stated as an index which is the sum of the links from a given place to all other places in the network by the shortest routes. The use of accessibility index permits more specific ranking of nodes than say with connectivity indexes.

(i) Rural Non-Farm Economic Activity.

In the present study the definition of rural non farm economic activity is that as used by ILO (1993) where rural non-farm economic activity refers to all non

agricultural activities manufacturing, construction, trade, commerce and services located in rural areas and undertaken by farm as well as non-farm households.

(j) Zone of Influence

In order to examine the impacts of a road it is necessary to define its zone of influence.   Some studies have assumed a fixed distance either side of a road. Others a fixed journey. ˙In this study the area of influence of the feeder road facility studied is considered in the framework of three zones. (1) 0-2km distance from the feeder road. (2) 2-5 km. distance from the road (3) 5-8km from the feeder road.

(k) Rural Sector

This refers to the rural farming community in the study area especially the small scale farmers.

(l) Road Density

This refers to the total length of classified road per square kilometres.

(m) Trading centres

These are small central places with a few general retail shops in the study area.

(n) Market centres

These refers to larger central places in which the periodic markets are held. They also host a variety of tertiary services.

(o) Shimbel Index

This refers to the number obtained by summation of either row or column totals in a connectivity matrix. This number indicates the most and least accessible points.

(p) Associated number

The associated number for a node refers to the highest of the shortest path links connecting that node to all others.

1.6.2   Transport: Operational Concepts in the Model

This concept refers to the movement of people and goods along the transport networks. Flows are the volumetric measures of the interaction and the successful interrelationship of other components.

Road Transport system

The transport system includes the flows, network and the modal system. All of these are meant to provide transport service.

Interaction

This concept refers to the movement of people, goods and services and the flow of information and ideas between two places. It also refers to the fact that as man speeds up his movement it becomes possible to increase accessibility. In this way secondary and tertiary functions can serve more people and perishable agricultural products and other primary products can be profitably marketed over a large area.

Modal system

This include all mobile transport equipments such as vehicles.
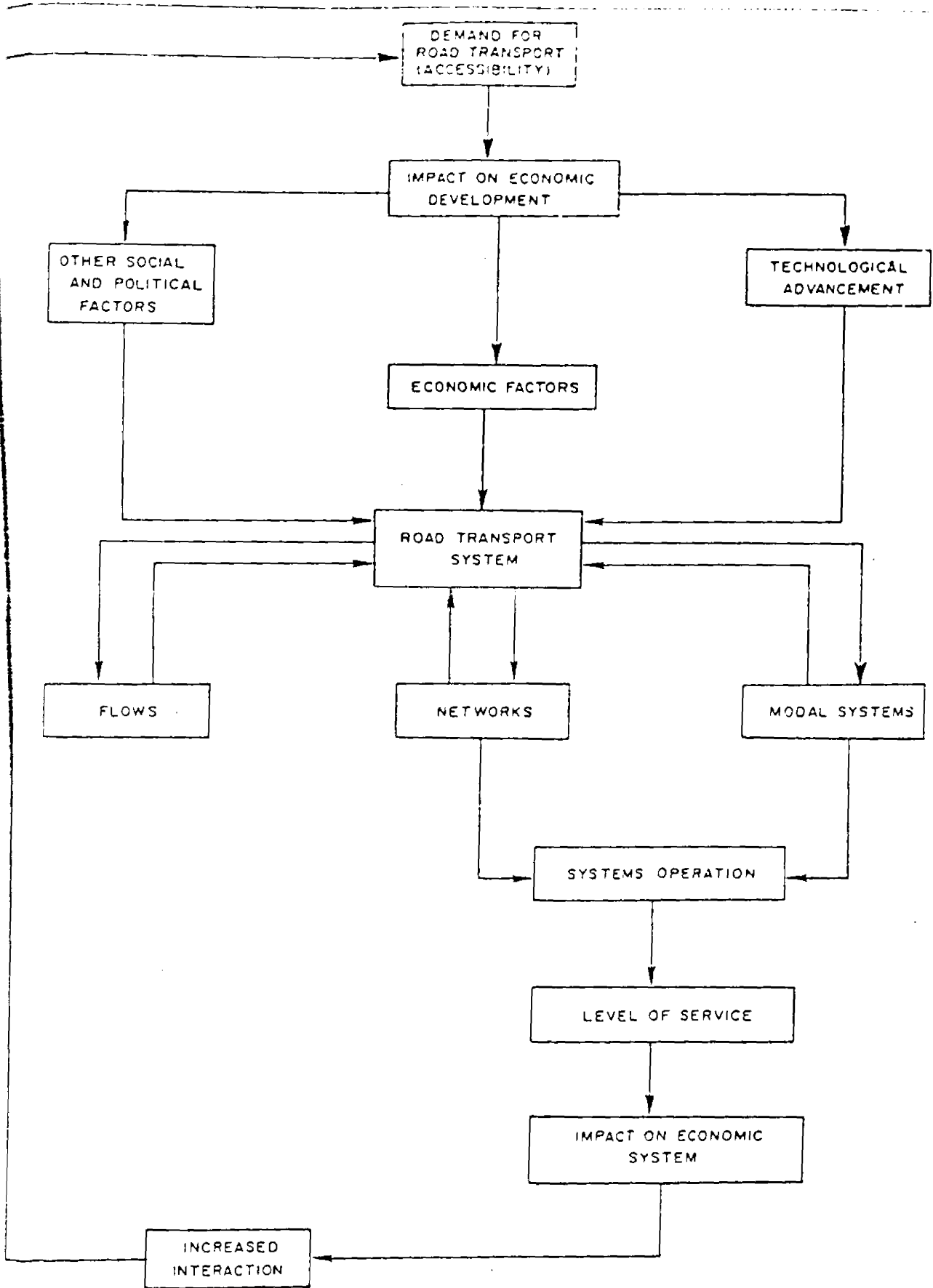
Figure: 1.4   Conceptual framework for studying economic impacts of roads.
Modified from Hurst, (1973) and Irondu, (1995)

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System Operations

This concept refers to the modal system and the network system.

Level of service

This concept refers to the nature of transport service provided by the Stock of transport system such as vehicles, roads and other associated facilities.

1.6.3 Conceptual/Theoretical Framework

The conceptual/Theoretical framework used in this study is a functional and systems approach. The framework is functional in that it emphasizes the development of a region in terms of some functions of their characteristics. The framework is also systematic in that transport structure is understood in terms of its relationship to other elements in the general system. The conceptual framework used in this study is modified from the model developed by Hurst (1973) and Irandu (1995).

Hurst's (1973) model has been extensively applied in the study of aspects related to the geography of transport. The model is useful, for it provides the basis for the study of transport system as:

1.   An inventory (stock of road, route, number of vehicles etc).

2.   A network comprising the geometric structure of the route system.

3.   Flows examining what movement occurs and how intensively.

4.   As the inter-relationship of the three element noted above.

The model for the present study consist of the transport system. This comprises the transport inventory and stocks. This system is geared towards the provision of adequate transport service to the society.

The main stages of the model are shown in figure 1.4 above. In the figure the basic structural components of the transportation system itself are the modes, stocks and networks. In the model the demand for road transport is followed by the requirement for technological innovation in modal system, stock and network structure. This will have an effect on economic development of a region or an area. These effects are felt in the social, political and economic system.

The network structure and flows on network have an effect on the overall economic development of the society. The level of service provided by the transport system will have an impact on the economic system. These impacts finally result in an increase in the level of interaction which will be transferred back to demand for accessibility and the cycle is complete.

1.6.4: Other Theoretical Frameworks for the Study of Economic Impacts of Rural Infrastructure

The relationship between rural infrastructure improvement and ultimate gains in economic and social welfare is presented in figure 1.5 below. Rural feeder roads and other improvement in rural infrastructure are viewed as having three types of impact. First, they can influence the production behaviour of rural inhabitants. Second, they can contribute to an improved pattern of income distribution. Third,

Rural Road Improvements (C_1)

Other improvements in rural services (C_1)

Resource Base

Market Demand

Known Inputs (I_1)

New Inputs (I_2)

Efficient Prices (I_3)

Management Skills (I_4)

New Activities (I_5)

Scale Economies (I_6)

(S_1) Political System
(S_2) Value System
(S_3) Institution System

Entrepreneural Acceptance (A)

Increased Output / Income (Y_T)

Improved income Distribution (Y_D)

Improvement in
(W_1) Nutrition
(W_2) Health
(W_3) Shelter
(W_4) Education
(W_5) Citizen Rights

and ultimately most important, they can contribute to improvements in the quality of rural life in terms of better shelter, better integration between the urban and rural population segments.

The provision and improvement of rural infrastructure affect some type of input to the production system in rural areas. As shown in figure 1.5 above, the influence can take many different forms. Increased quantity and quality of inputs already used by the farmer is one possibility. New inputs e.g. fertilizers, animal feeds, seeds etc. are another. More efficient prices, improved farm management, new crops and widening of markets also represents potential types of impact. Several of these potential impacts and changes are likely to be confronting rural entrepreneurs as they make their decisions on what level of output to produce.

The effectiveness of provision of a specific type of rural infrastructure depend upon how rural entrepreneurs receive those changes. They will view such changes through the political system, the value system and the institutional system which define their environment.

Rural infrastructure investments are transformed into gains in social welfare primarily through increases in rural output. Higher output translates into higher income and improvement in various component of social welfare.

Figure (1.6) above provides a schematic representation of the impacts of feeder road provision and improvement in the rural economy.

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CHAPTER TWO

THE STUDY AREA

2.0 INTRODUCTION

The geography of an area has great influence on resource endowment, transport networks and the pattern of socio-economic development. This chapter, therefore, analyses the geographical features of Thika District with particular attention to those features which have important bearing on economic and general development. The features include position and size, relief and drainage, climate, population, administrative units among others.

2.1 LOCATION AND SIZE

Thika District is one of the seven districts in Central Province. The district was carved in 1994 from Kiambu and Murang'a Districts and it is located in the southern part of Central Province. It borders Nairobi to the South, Kiambu District to the West, Maragua District to the North and Machakos District to the East.

Thika District covers an area of 2,024 sq.km.. It has six administrative divisions, namely Thika, Gatanga, Kakuzi, Ruiru, Gatundu and Kamwangi. The district has a total of 20 locations and 89 sub-locations. The administrative and political units are illustrated in table 2.1

Table 2.1: Thika District, Administrative Units by division, Location and Sub-location

Division	Area (km²)	Location	Sub-location
Thika	272	2	7
Gatanga	259	4	17
Kakuzi	487	4	11
Ruiru	526	2	7
Gatundu	186	4	24
Kamwangi	294	4	23
TOTAL	2024	20	89

Source: District Commissioner's Office, Thika (1998).

2.2 RELIEF AND DRAINAGE

Thika District has a diverse topography with altitudes varying from 1,060 to 3,550 meters above sea level. The highlands along the slopes of Aberdare ranges form the water catchment areas and water sheds of most rivers which drain to the lowlands. Most of the rivers within Thika District flow parallel from the Aberdare ranges to the West, then south eastward to join Tana River.

The dissected topography in the district has greatly influenced the lay out of transport network especially road transport. Most of the feeder roads run parallel to the rivers along the ridges to join the main Nairobi-Sagana Highway. Roads running parallel to the rivers are dominant in Gatanga, Kamwangi and Gatundu divisions. Only the main feeder roads have been slightly improved in Thika District, hence varying degrees of accessibility are afforded in the region.
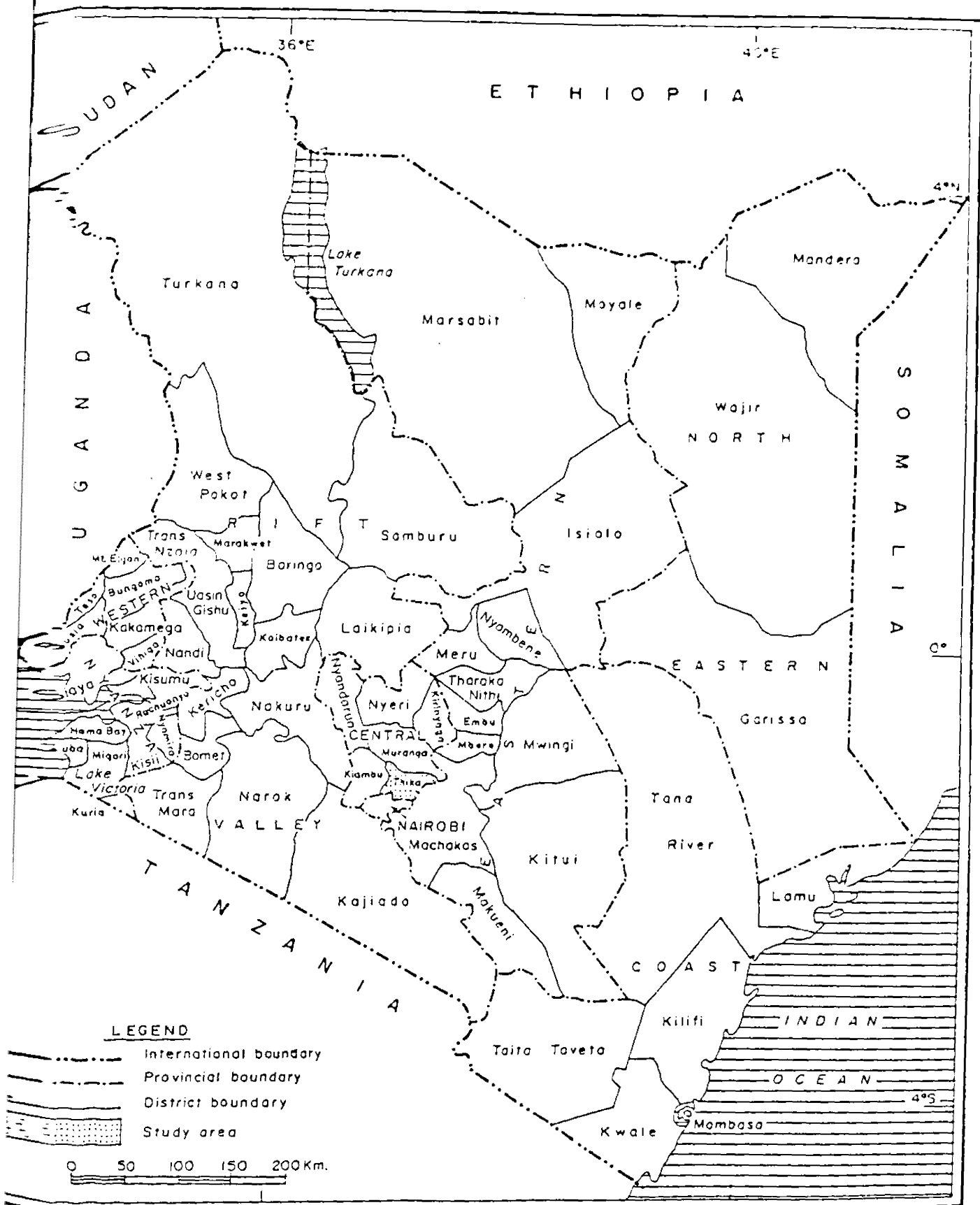
Figure 2.1 Location of Thika District in Kenya
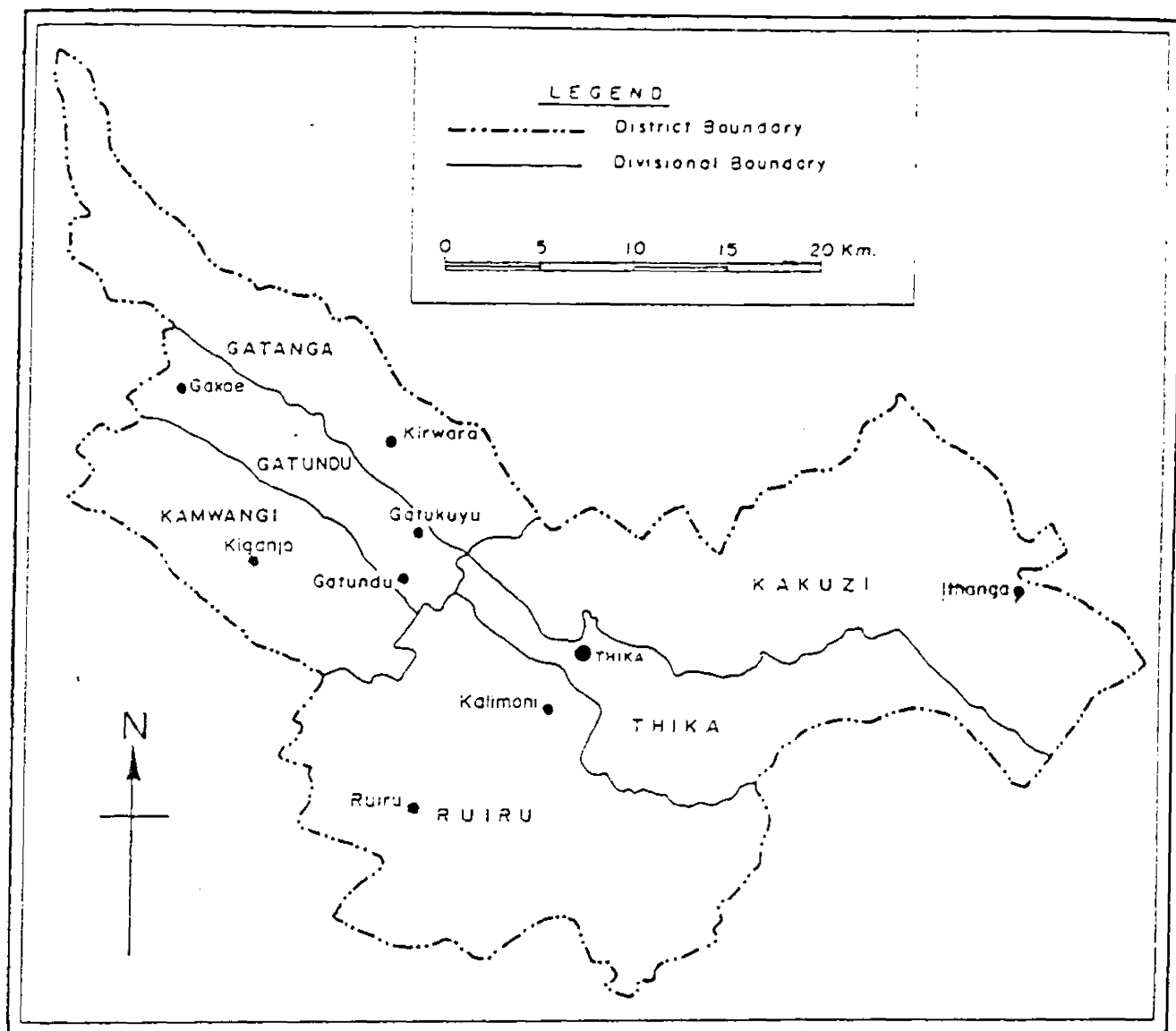
Figure 2.2 Thika District: Administrative Boundaries
Source: Department of Resource Survey and Remote Sensing (DRSRS)
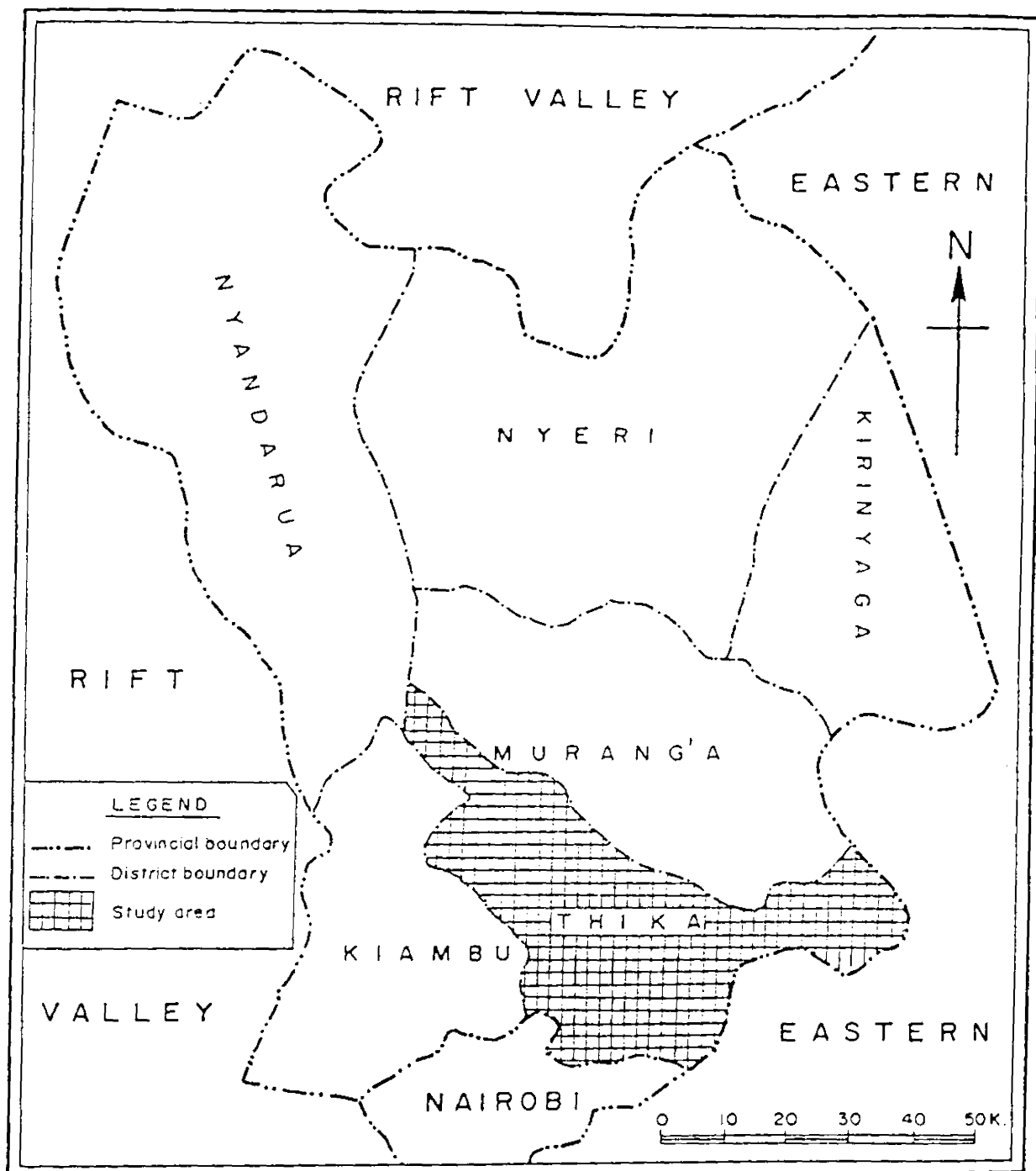
Figure2.3 The location of Thika District in Central Province.

The low land areas in the eastern parts of the district are generally marginal lands and receive low rainfall. Owing to these conditions, the level of economic activities is low and interestingly the road network is poorly developed in these areas These areas cover Kakuzi, Thika and Ruiru Division. Numerous streams and valleys in these lower parts of the district necessitate construction of many bridges to connect one ridge to the other.

2.3 DRAINAGE AND CLIMATE IN RELATION TO AGRICULTURAL ACTIVITIES

The climatic conditions prevailing in the district are largely determined by the altitude that is, height above sea level. The district annual rainfall ranges from between 500-2500 mm. This rainfall, like in most other areas in the highlands East of the Rift Valley is received in two rainy seasons, (Bimodal rainfall pattern) which are the long rains and the short rains. The long rains occur in the months of March to May while the short rains are received in the months of October and November. There is however, a wide spatial variation in the rainfall distribution. The rainfall regime in Thika District combined with other climatic factors have greatly influenced agricultural activities. In the western and Northern parts, where minimum rainfall of 1500mm per annum is received, coffee, tea and Dairy farming activities are carried. This zone is therefore the most productive in the district.

LEGEND

UH0	Forest Zone
UH1	Sheep and Dairy Zone
LH1	Tea and Dairy Zone
UM1	Coffee and Tea Zone
UM2	Main Coffee Zone
UM3	Marginal Coffee Zone
UM4	Sunflower and Maize Zone
UM5-6	Livestock/Sorghum/Ranching Z.
LM4	Marginal Cotton Zone
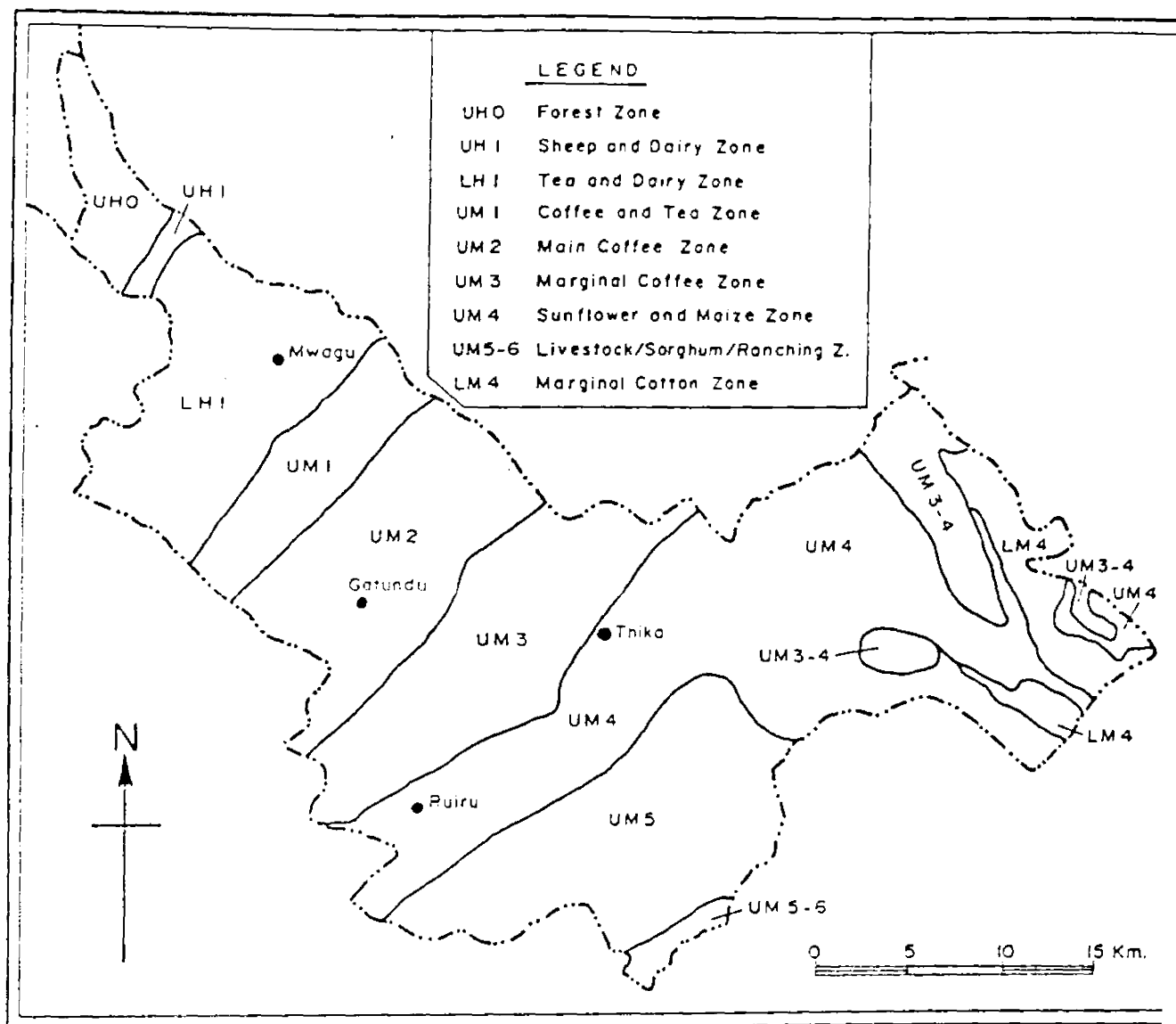
Figure 2.4   Thika District: Agro-Ecological Zones

Source: Department of Resource Survey and Remote Sensing (DRSRS)

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Horticultural farming activities are concentrated mostly in the middle agro-ecological zones especially in Gatanga, Gatundu and Kamwangi Division. In the recent past owing to poor performance of the traditional export crops namely, tea and coffee, there has been a tendency for small scale farmers in the middle zones, to replace these crops with horticultural crops. As a result, horticultural activities in the district have increasingly come to play a crucial role of raising incomes for the small scale farmers.

In the relatively drier areas in the east of Thika district, where rainfall is low and un-reliable, beef cattle farming and production of drought resistant crops including sorghum and millet have been doing well.

Generally the climate of Thika district is conducive to production of a variety of crops including Tea, Coffee, French beans, Macadamia. Pineapples and numerous varieties of other horticultural crops. The area has well drained soils favourable for cultivation of the above crops.

2.4: THE GEOLOGICAL BASE IN RELATION TO AGRICULTURAL ACTIVITIES

The geology of the District consists of volcanic rocks of the pleistocene age and Mozambique belt. Volcanic rocks occupy most of the western part of the district bordering Aberdare Mountains, while rocks of the Mozambique belt or the basement system are largely found in the Eastern part of the district.   The wide variations in altitude and temperatures between the highlands and lowland

areas combined with the underlying geology have given rise to a variety of soil types. This variation in soil types result in differences in the general fertility and hence the land potential for agricultural activities.

Soils in the district fall broadly under five categories which can be classified into four general fertility groups. High to moderate fertility soils are found mostly in the western part of the district especially in Gatanga, Kamwangi and Gatundu divisions. The quality of this type of soil allows for the profitable cultivation of tea, coffee, maize, beans and a variety of horticultural crops including the Indian vegetables. Lower fertility soils are found mostly in the eastern part of the district especially in Thika Division. This region suffers from poor drainage system and soils in the area are shallow. This condition, coupled with low and unreliable rainfall severely limits agricultural activities in the area. However, these areas have the potential for ranching and the cultivation of drought resistant crops.

2.5 DEMOGRAPHIC CHARACTERISTICS

2.5.1 Population Size

Based on data obtained from the 1989 population census, Thika district which was a part of Muranga and Kiambu districts had a population of 489,306 persons. This population is projected to increase to 692,946 persons by the year 2001.

The rapid growth of population in Thika district, which is estimated to be at the rate of 2.9 percent has considerably affected the resource base. For instance, this rapid growth in population has created enormous pressure on the small scale

farmers with land becoming smaller due to land subdivision. For instance, in the small farm sector the average size of land holding ranges from 0.5 ha in Gatanga to 2.7 ha in Kakuzi. Overall the average size of land holding is 1.2 ha. This has adversely affected agricultural production in terms of yield and output. The table below shows the population size projection for Thika District.

Table 2.2: Thika District Population Projections by Division in km^2

Division	1989	1997	1999	2001
Thika	76286	96203	101948	108035
Ruiru	73575	92785	98325	104196
Gatundu	101297	127745	135372	143455
Kamwangi	87286	110075	116648	123613
Gatanga	90900	114633	121478	128731
Kakuzi	59962	75617	80132	75383

Source: District Statistics Office, Thika (1997).

2.5.2 Population Distribution and Density

The population in Thika district is unevenly distributed. Most of the population is concentrated in Gatundu, Kamwangi and Gatanga Division as indicated in Table (2.2). These divisions are endowed with good climate and soils which are favourable for agricultural activities. For instance in the small farm sector the average size of land holding ranges from 0.5 hectare in Gatanga to 2.7 ha in Kakuzi. Overall the average size of land holding is 1.2 ha.

Table 2.3:   Thika District Population Density Projection by Division

Division	1979	1989	1997	1999	2001
Thika	272	280	371	386	401
Ruiru	526	140	185	193	200
Gatundu	186	544	719	750	778
Kamwangi	294	297	392	409	424
Gatanga	259	351	418	430	441
Kakuzi	487	123	147	151	155
Total	2024	242	310	322	333

Source: District Statistics Office, Thika (1997).
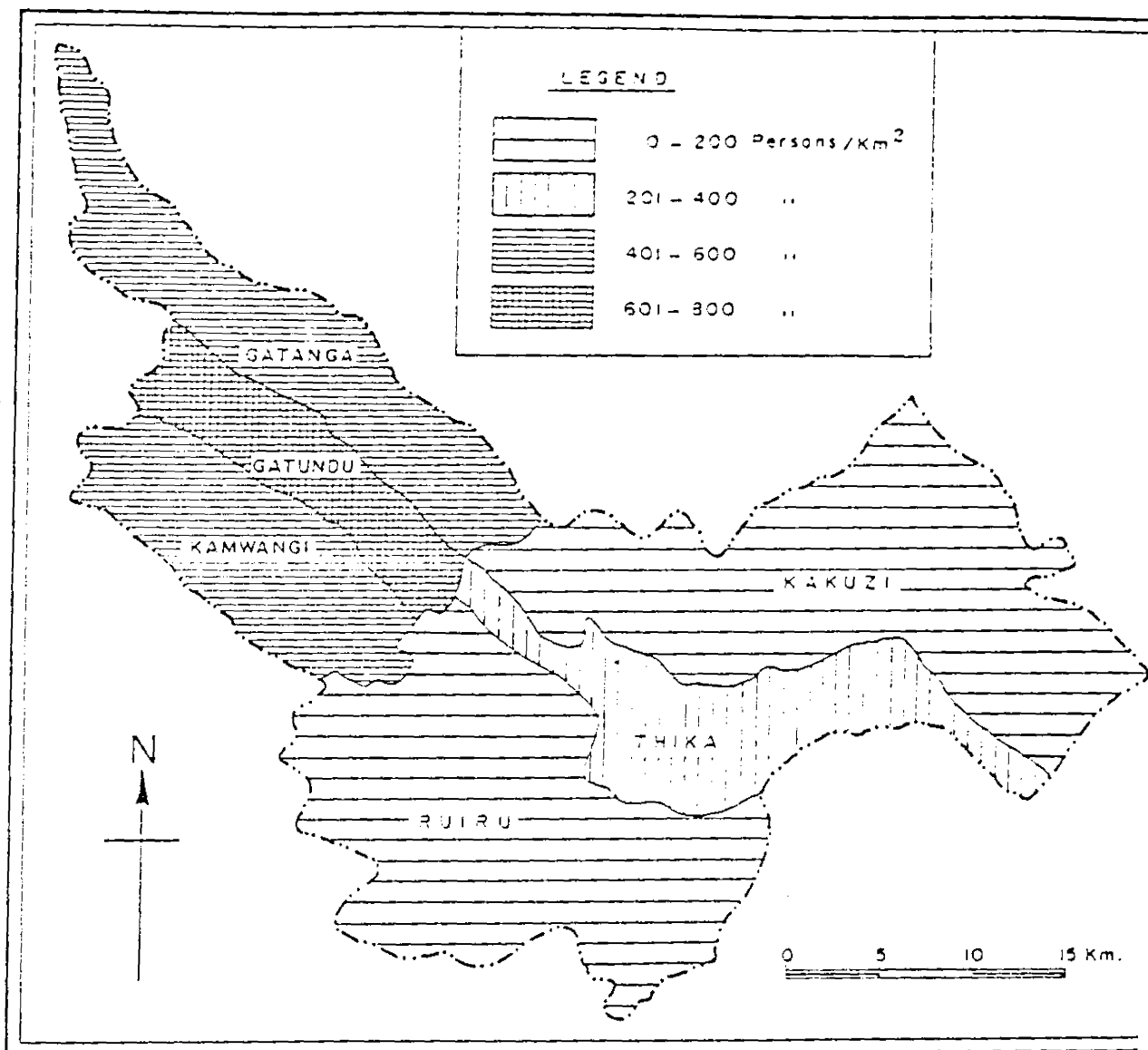
Figure 2.5 Thika District: Population Density per administrative division boundar

The three divisions are also in close proximity to Thika municipality which is also the leading urban centre in the District. At the national level the district is densely populated when compared with other districts in Kenya.

The district population is largely rural. Table (2.4) below indicates this.

Table 2.4: Thika District Rural and Urban Population, Census

Figures (1989)

RURAL POPULATION		URBAN POPULATION	
Division	Total Pop.	Urban Centre	Total
Thika	18,683	Thika	57603
Ruiru	50,259	Ruiru	23316
Gatundu	101,297	-	-
Kamwangi	87,286	-	-
Gatanga	90,900	-	-
Kakuzi	59,962	-	-
Total Rural	408,387	Total Urban	80919

Source: Thika District Development Plan, 1997-2001

According to the 1989 Census figures about 86 percent of the population in the district lived in rural areas and in small rural market centres. Approximately 14 percent of the population lived in urban centres. The urban population in the district is largely concentrated in two urban centres namely, Thika and Ruiru. These towns have attracted migrant workers from all over the country because of their industrial activities.

Other up-coming small towns and market centres with a considerable urban population include Gatundu, Gatura and Kakuzi. These centres are relatively served well by socio-economic infrastructure which provide better opportunities for industrial growth. They form the hub of future development for urban centres in Thika District to support the nearby rural areas. It is in these centres that considerable potential for generating non-farm employment lies.

2.6 MAJOR ECONOMIC ACTIVITIES

As indicated above about 86 percent of the population in Thika District is rural based. This population is engaged in agricultural activities varying from crop farming to livestock farming. Most of the working labour force are therefore engaged in their own farms as small scale farmers while the rest are employed in large farms and plantation as labourers and workers.

2.6.1 Small Farm Sector

Thika District is divided into 243,636 small farm holdings which are owned by 81,212 farm families. Most of the inhabitants are small scale farmers who are engaged in the production of a variety of cash crops and subsistence crops. The average size holding is 1.2 hectares. Maize, Beans and Bananas are the main staple food crops in the district. The small farm sector contributes the largest share of cash crop produce including horticultural cash crops such as French

Table 2.5: The size of the small scale farming sector

Division	Rural household land/ha	Average household land/ha	Main food crop(s)	Main cash crop(s)	Percentage Household with high value cash crops	Percentage Household with high value food crops
Thika	14077	1.06	Maize, beans and peas	Horticultural coffee	29	15
Ruiru	10796	2.5	Maize, Beans	Coffee/ Horticulture	28	13
Kakuzi	16850	2.7	Maize, Beans	Pineapple/ Horticulture	40.3	13.4
Gatanga	15087	0.5	Maize/beans	Tea, coffee	37	40
Gatundu	26400	0.76	Maize/Beans	coffee/ Horticulture	36	40
Kamwangi	17500	0.6	Maize/beans	Horticulture Maize Coffee	35	40

Source: District agricultural annual Reports, Thika 1995-97.

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Beans, Macadamia, Pineapples and a variety of Indian vegetables. From the above table it is apparent that maize and beans are the major food crops in the study area. Other important food crops include: Irish potatoes, Sweet potatoes, Cassava, Yams, Bananas among many more others. Most of these cash crops especially horticultural crops are grown for the export markets. Horticulture among small scale farmers is also coming up as an important activity in the district. Horticulture products are purposely produced for export to Europe. About 36 percent of the households in Gatanga, Gatundu and Kamwangi Division have high value cash crops (District Agriculture Office, Thika, 1997). These high value cash crops include a variety of horticultural crops grown for export market.

2.6.2 Large Farm Sector

Thika District has a considerable share of large scale farms dealing with cultivation of major cash crops. These includes coffee plantation, Pineapple plantations and horticulture farms.

Delmonte Kenya Limited is one of the largest plantation farming company dealing with pineapple cultivation. Its plantation is located in Kakuzi Division. Kakuzi Limited is another large scale coffee farming company and is also located in the district. It also practices horticultural farming and ranching on a large scale. Most of these large scale plantations owe their origin During the colonial era.

Table 2.6: Major crops and Number of Hectares Under these Crops in the Large Farm Sector

Division	Main Crops	Number of Farms	Total area in Hectares
Thika	Coffee, Horticulture	16 5	4406 2301
Ruiru	Coffee	61	7560
Kakuzi	Coffee Pineapple	2 1	5500 4500
Gatanga	Coffee Horticulture	1 13	160 65
Gatundu	Coffee Horticulture	58 13	210 105
Kamwangi	Coffee Tea	1 2	200 110

Source: Thika District Agricultural Office 1997.

2.7 HORTICULTURAL FARMING ACTIVITY

Horticultural farming activities in Thika District are widely spread in all the divisions. Most of the horticultural crops grown in the district are dominantly produced by small scale farmers except pineapples which are cultivated by Delmonte Kenya Ltd on a large scale. This company operates in Thika and Kakuzi Divisions.

The city of Nairobi and Thika municipality provide a ready market for most of the horticultural products. These crops are also sold to the export market. It is generally claimed by most of the stake holders of agricultural activities that the development of horticultural activities in Thika District is hindered by poor and inadequate transport facilities. However, empirical studies to substantiate this claim have not yet been done, hence the significance of this study.

2.8 INFRASTRUCTURAL BASES FOR DEVELOPMENT

2.8.1 Standard Infrastructure

The term standard infrastructure includes public utilities, transport, schools, hospitals, power, water supply, ports, drainage etc. Those are the basis upon which other development activities are laid. The focus of this study is on rural road infrastructure. Therefore, some elements mentioned above such as port facilities for example are not directly relevant to the present study. The major element of rural infrastructure include transport and communication.

Since transport facilities have an important influence on land use and location of economic activities, it is important to have a background information on

the nature of the transport networks in Thika District.

Road transport is an important factor for economic development in rural areas of Kenya (Kenya National Development plan (1997-2001). It facilitates movement of raw materials, inputs, finished products and information. Thika District has a total of 1032 km. of classified roads, which includes international trunk roads, primary roads, secondary roads, tea roads, minor roads and rural access roads. About 363 km. of the total road surface is bitumen. This represents approximately 35 percent of the total classified road in the District. Table 2.5 below shows road classification in Thika District in 1997.

Table 2.7: Road Network by class and length, 1997

Type of Road	Class	Length (km.)
International Trunk Roads	A	130.8
National Trunk Roads	B	0.0
Primary Roads	C	97.6
Secondary Roads	D	199.2
Minor Roads	E	553.8
Tea Roads	T	21.0
Rural Access Roads	R	30.4
Total		1032.8

Source: Thika District Public Works Office.

Class D E T R can be generally regarded as rural feeder roads as they link the rural villages with the main trunk roads and primary roads. These are the roads that are used in the delivery of inputs into the villages in the rural areas. They are also used in delivering outputs from the villages to the urban markets.

LEGEND

—·—·—·—	District Boundary
▬▬▬▬▬	International Trunk Roads
————————	Primary Roads
—·—·—·—	Minor Roads
————————	Secondary Roads
— — — —	Other Roads
O	Towns or Trading Centres

MURANGA

Ndakaini

Gakoe   Gatura

Kirwara

Gatanga

Gatukuyu

Kignnjo   Ithaga

Gatundu

THIKA

Nembu

Juja

KIAMBU

Jiru

MACHAKOS

0   5   10   15 Km

NAIROBI
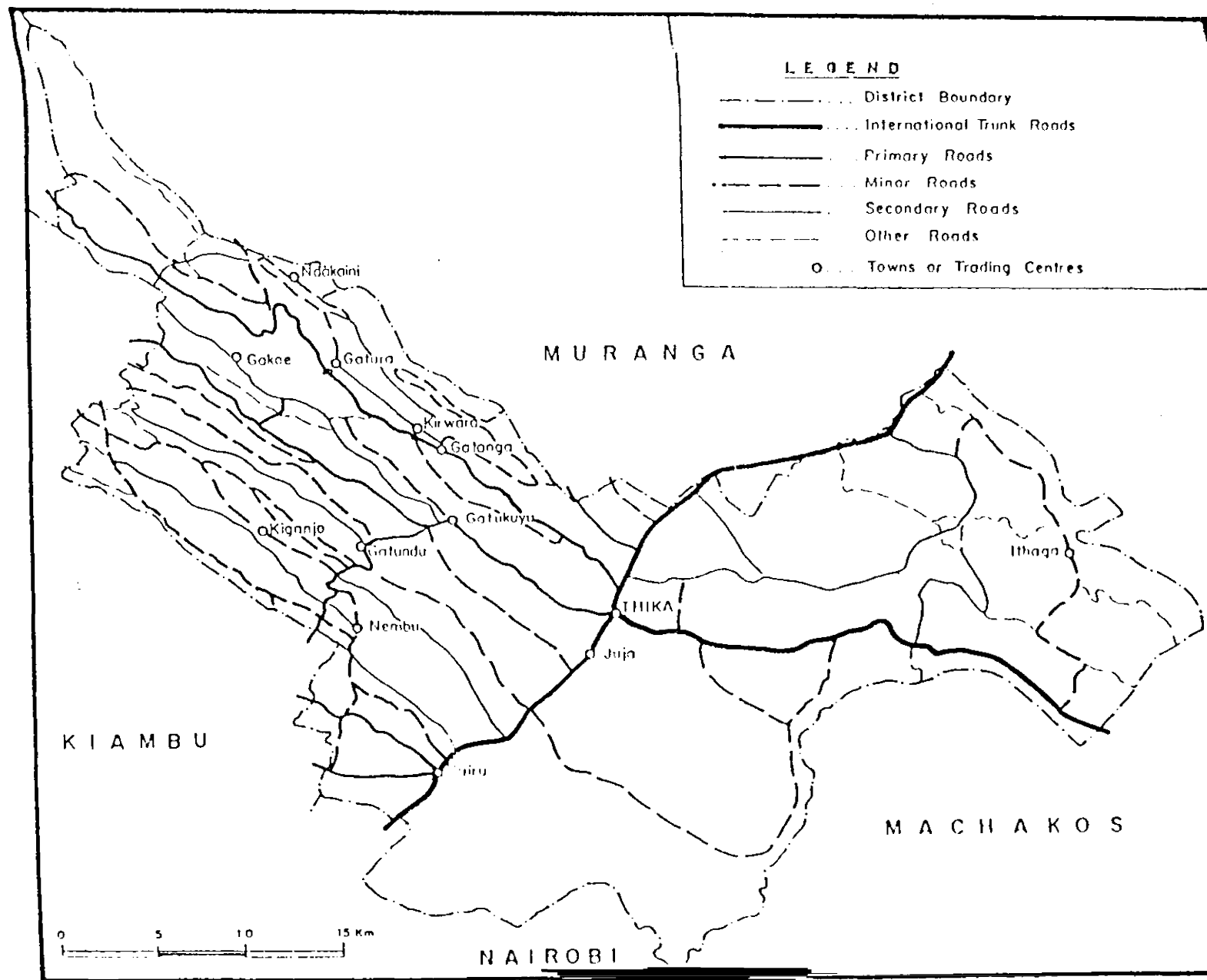
Source: District Physical Planning Office, Thika

2.8.2 Historical Perspectives of Agricultural Development in Kenya in Relation to Road Transport

The development of agriculture in Kenya has been influenced directly or indirectly by the provision of transport facilities. Before the advent of colonialism in Kenya most of the agricultural activities among many communities were traditional in the sense that they were subsistence oriented, to meet the requirement of the local population. The crops grown were mainly food staples. Modern agriculture was therefore introduced by the colonial administrators and farmers especially, the white settlers.

The impact of the colonizers on the existing agricultural systems varied widely between and within communities. Essentially, the colonizing powers introduced two basic agricultural innovation to Kenya; (a) cash crop and (b) New land tenure.

The colonial government played an important role in the development of agriculture in Kenya. The building of the Uganda railway between 1897-1901 was one of the most important infrastructural investments made to open East Africa to the rest of the world through Mombasa Port. After building of the railway, the vast agricultural resources of East Africa that lay idle could now be tapped and the agricultural raw materials produced would be exported to established factories in Europe.

After the completion of the Uganda Railway in 1901, the British imperial authority was established. White settlement in Kenya was stimulated by colonial

government which gave the settlers large concessions of high quality land on a 1999 year leases. In this way massive tracks of land in form of thousands of hectares were given to white settlers in Kenya.

White settlement as a policy was adopted in 1902 although by that time a handful of pioneers were already on the scene (Ross, 1927). The crown land ordinance of 1902 had the effect of putting all land in the country under the crown thereby making it easy to alienate specific areas for occupation by the new settlers.

At first Access to the Railway determined the ability to produce for the export market. Transport costs contributed a high percentage of total costs so that distance from the railway determined the potential profitability of land. As a result of this many white settlers established their farms near the railway line. This led to infrastructural development occurring along the railway line especially within the established trading centres.

The need to open up the interiors to start trade prompted the designing of a road pattern to fulfil this desire. The economic regions developed were supplied with a transport system to tap the resources. This was especially so in the so called white highlands of Kenya. This preference to white highlands development resulted in constructing railways and roads which penetrated these development zones whose role as it has been stated before were to tap resources and not integrate and transform rural or regional areas.

The dendritic pattern of transport network that emerged was therefore

designed for the purpose of administration and agricultural exploitation. The extent of agricultural development in the areas of efficient transport network shows the effects these transport networks have hand on agricultural development.

The roads and railways were designed to pass through high potential agricultural areas. It is worth noting that the colonial building of roads was not planned to serve the indigenous rural people but to exploit the resources of the land. The railways were the backbone of the transport system in Kenya and the connecting feeder roads system linked the railway to other urban centres and to zones of agricultural production.

Development therefore followed closely the transport network especially the trunk routes in a series of ribbon development.

By 1906 only coffee and potatoes crops which had been established for cultivation on a significant scale (Huxley. E. 1935 p.108). Arabica coffee was established almost as soon as the first settlement began in Nairobi area. The crop had been introduced into the highlands at Nairobi and at Kikuyu, from a small plantation in Taita hills. Coffee growing was thus first established in the Nairobi/Thika areas and from there it later spread to other districts which were well connected to the railway by feeder roads.

The early development in agriculture in the highlands was interrupted in 1914 when the First World War broke. Between the period 1914-1918 agricultural sector suffered, mainly due to the involvement of the settlers and the colonial power in the war. This was associated with neglect of the agricultural sector and

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the associated decline in productivity.

After 1920 agricultural activities began to recover from the dismal performance recorded earlier. This saw the extension of already launched agricultural plantations. Many more settlers also arrived in Kenya from other countries especially South Africa and Britain. These white settlers as they were called came to settle in Kenya as farmers. By 1930 the Nairobi-Thika area was beginning to develop into a plantation zone with most of the coffee and sisal estates being located there. The advances in agriculture during this period were made possible first of all by the improvement of transport facilities including the building of all the main rail extension to open up the new areas for settlements. The rapid expansion of coffee and sisal growing in the area north east of Nairobi and Thika area had prompted the building of a "tramline" to Thika in 1913 and this was later made a railway line which was developed and extended to Nanyuki by 1930.

Between the period 1920-1940 agricultural activities flourished well in the so called white highlands. The development of the feeder roads and feeder railway branches were constructed during this period. For instance, the Thika-Nanyuki railway branch was completed in 1930. The Thika-Kitui-Garissa road was constructed between 1921-1926. The Nairobi-Thika road was constructed between 1900-1920. Associated with this period of transport development and agricultural growth was the establishment of agricultural manufacturing industries such as Sisal, Tea processing, Bag and Cordage, etc.
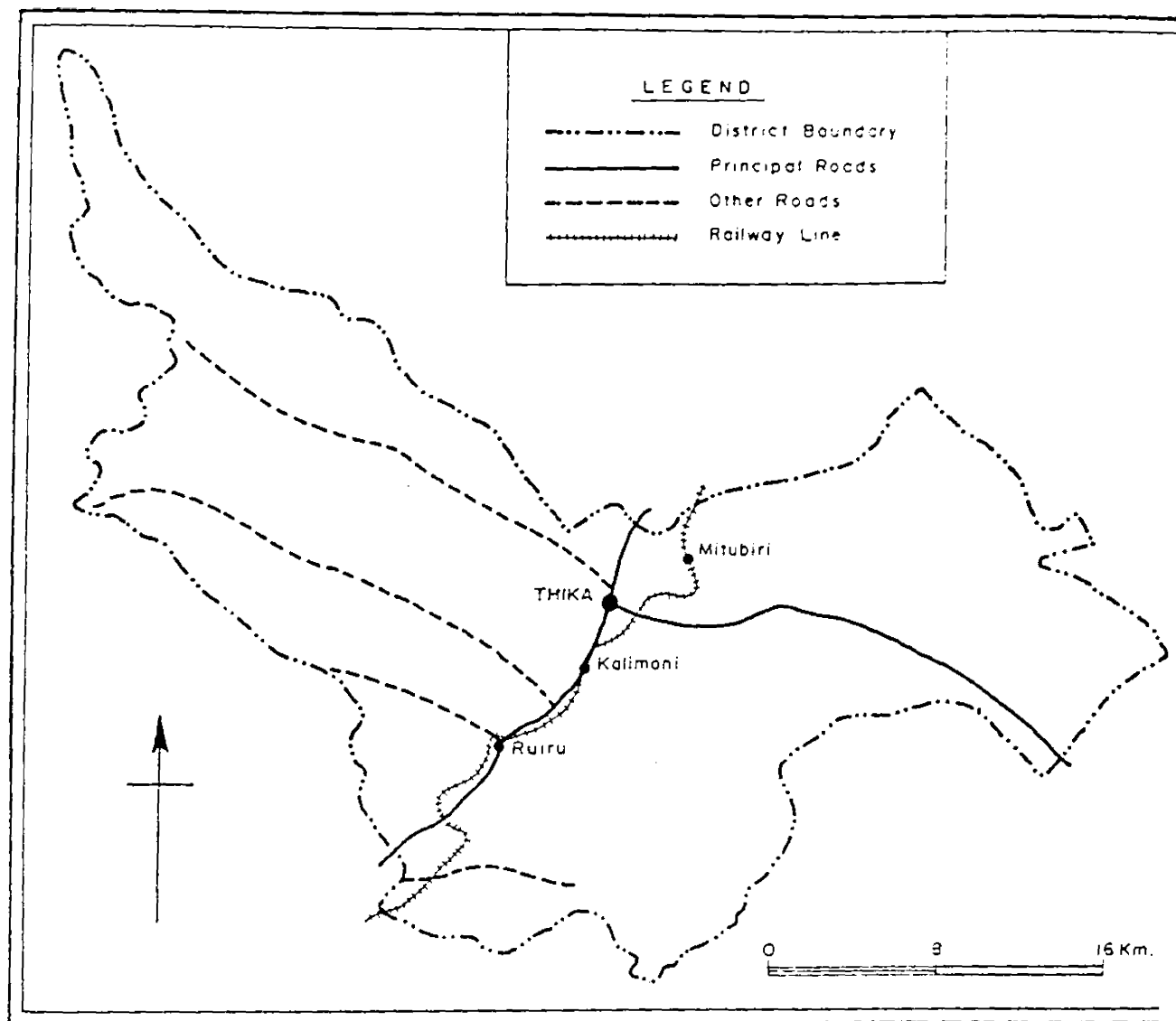
Figure 2.7 Thika District Transport Network in 1920's

It is instructive to note that the colonial government encouraged and promoted the development of a dual spatial economy. The colonial spatial organization which was developed was a function of economic structure which was formed. This economic structure was divided into two major zones:

(a) The peasant agricultural zone.

(b) The white settler zone.

The peasant agricultural zone produced traditional products while the white highlands enclave was controlled by white settlers and produced goods for export.

The Sywnnerton Plan of 1954 laid down the steps that were to be taken in the development of African agriculture. Under this plan Africans were to be allowed to grow cash crops for the first time. This plan also set in motion the process through which African land consolidation would be made. Furthermore plans were also put in place to issue the Africans with their own title deeds. The Sywnnerton Plan gave Africans the mandate to grow their own cash crops and this paved the way for Africans to move away from subsistence agriculture to commercial agriculture. This was accompanied by increased agricultural productivity and demand for transport services, to move the surplus from the farms to the market.

The period after second world war and more so after the Sywnnerton Plan marked the beginning of improvement of feeder roads especially within the so called African reserve areas. This improvement in roads was associated with increased productivity among the peasant farmers.

2.8.3   The Development of Transport and Agriculture in Thika District

Before colonization, at the turn of the last century, transportation in Thika District, like in many other places in Kenya was done by human carriage which involved back loading and head loading. This transport comprised of African men and women carrying small quantity of produce for exchange with other goods (barter system of trade) especially with Asian traders who dominated the trade in the new trading centres opened along transport networks, such as Thika Town. Motorised road transport was introduced by the colonial administrators in Thika District at around 1920s. This transport system served mostly the colonial administrators, especially the district commissioners and district officers.

By the beginning of the colonial era agricultural activities among the Africans in Thika District, like in many other parts of Kenya were poorly developed and organized. In this system, the African communities produced food staples and subsistence mode of production was dominant. The road transport system by then comprised mostly of tracks and footpaths which were used by the people when travelling from one place to the other. It is important to note that when the colonial government began to construct these roads they were guided by this system of tracks and footpaths.

In the colonial frame work transport networks were built to connect administrative centres with an interior area of political and military control. The roads were also built to reach areas of potential agricultural production. In Thika District most of the land had been declared white highlands. Given this condition

early transport development in the area was mainly intended to serve the white settlers.

2.8.4 Colonial Spatial Organization of Agriculture in Thika District

In Thika District most of the highlands and lowlands with suitable soils had been declared by the colonial government as "scheduled areas" or the white highlands. These lands were set exclusively for settlement by the white settlers. Most of the large scale farms established during the colonial period are still maintained today in the district. Among the oldest plantations established during the colonial period in Thika District include, Delmonte Kenya Limited and Kakuzi Ltd. These farms still operate today although ownership has kept on changing hands. Other large scale coffee farm in Thika district also owe their origin during the colonial era. Today, the spatial structure of agricultural activities in Thika District has a lot of bearing and reflection on the colonial agricultural policy. For instance, the farm sector in Thika District falls into two major categories; namely the small scale farm sector and the large scale farm sector. These two major categories have differing and contrasting characteristics features. For example, the small scale farm sector comprises of individual households with title deeds to small parcels of land. These small scale farms are for the most part mixed in terms of cropping pattern. The household farmers in these small scale farm sector own land which on average ranges from 0.5 hectare to 1 hectare. On the other hand the large scale farm sector is organized, own large tracks of land and quite often grow only one cash
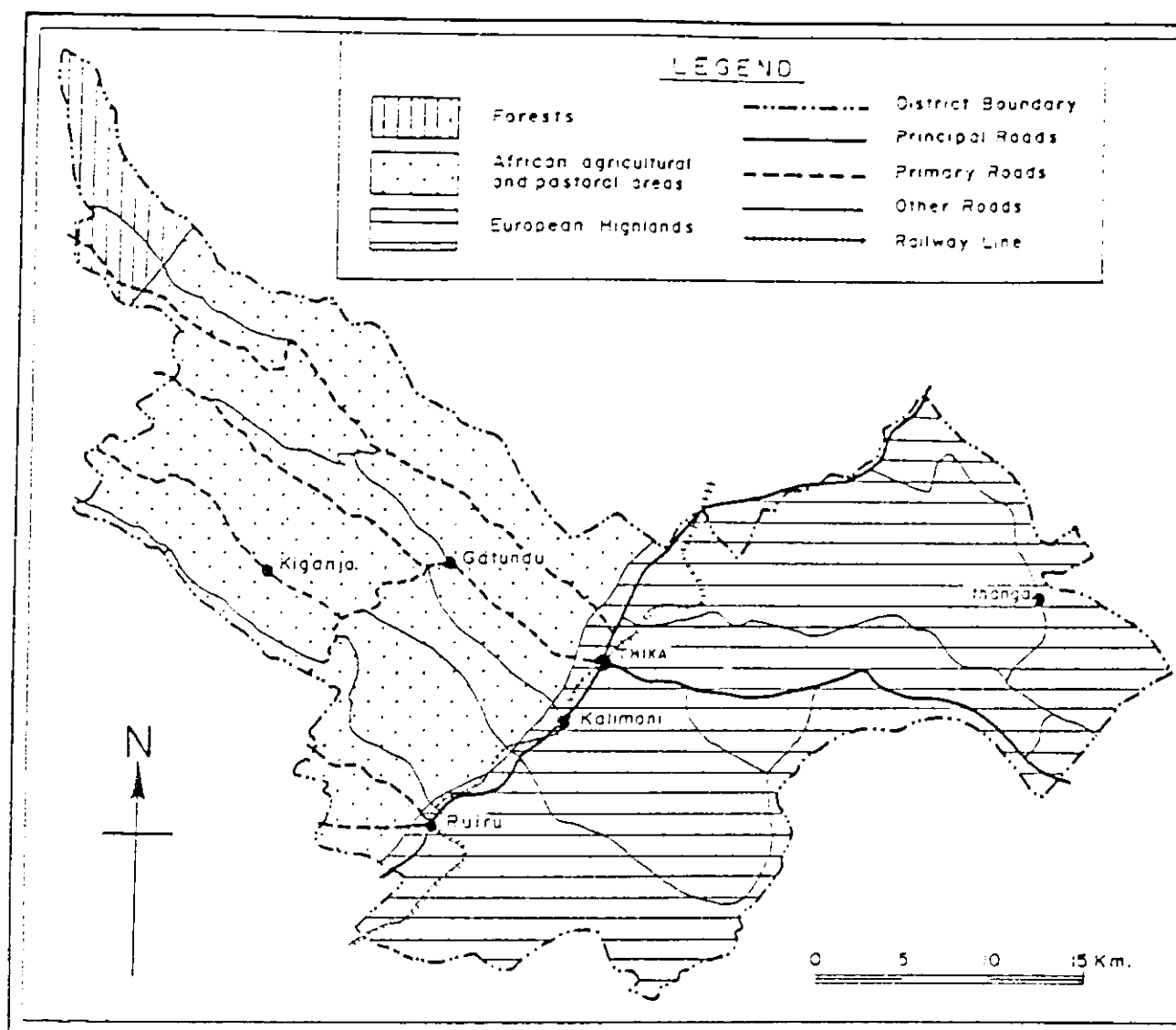
Figure 2.8 A map showing African reserves, White highlands and Principal roads   Source: Survey of Kenya,1952

LEGEND

─ · · ─ · · ─ · ·	District Boundary
──────────	Principal Roads
─ ─ ─ ─ ─	Other Roads
──────────	Principal Tracks
┼─┼─┼─┼─┼	Railway line
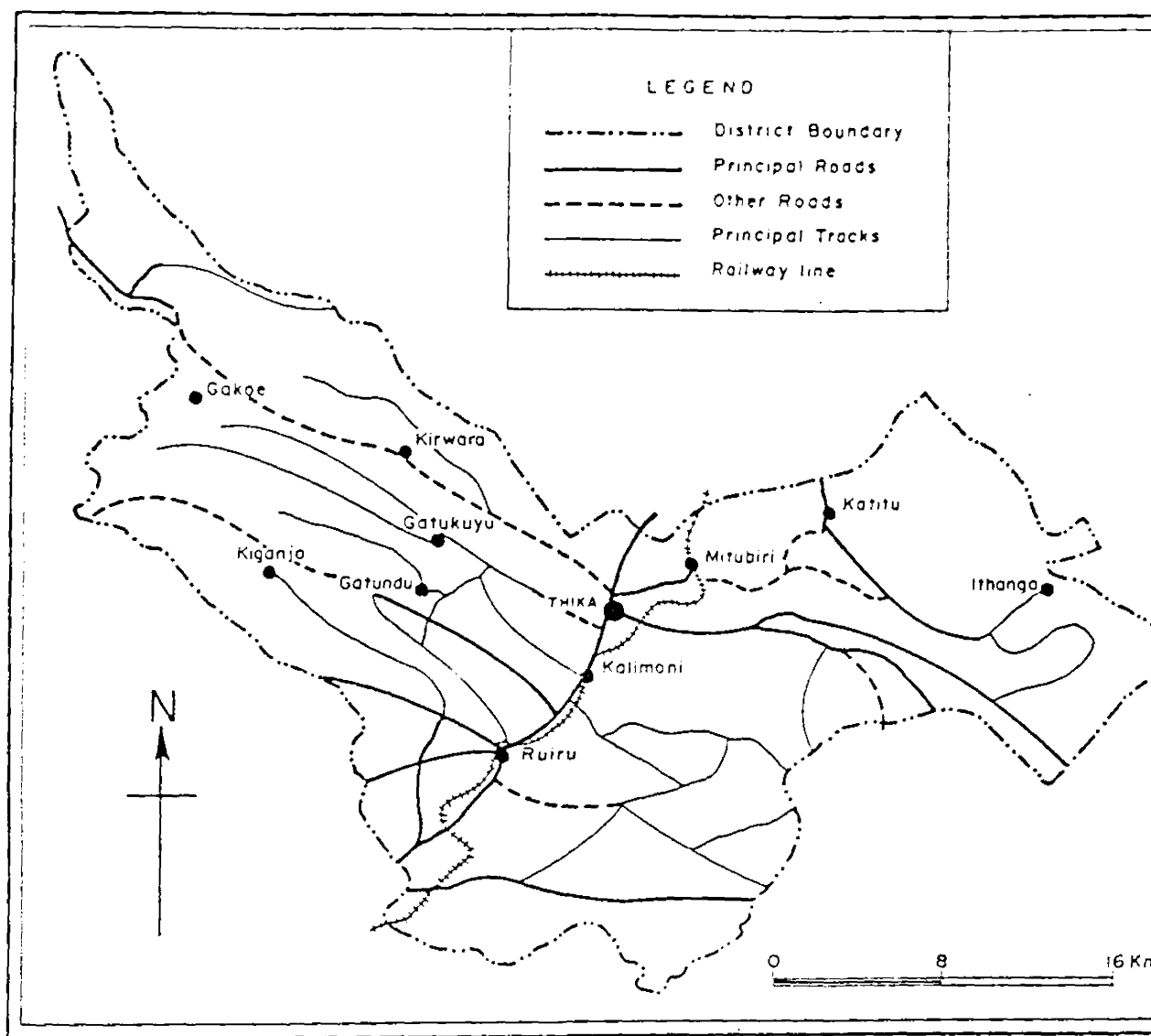
Figure 2.9 Thika District Road Network, 1959
Source: Reconstructed from Kenya Atlas, Survey of Kenya, 1959

crop e.g. Kakuzi Ltd. which specializes in coffee production.

The introduction of new cash crops by the White Settlers was very much influenced by the transport networks. Initially, new cash crops were first introduced in the most accessible areas but later on they spread to other areas which were opened up. For example, coffee was first introduced and grown for commercial purposes in Kiambu, Thika and Muranga areas between 1903-1920. Thereafter, the crops diffused to other areas especially those areas close to the newly established rail-line branches.

In Thika District coffee farms were first established around Thika town which was well connected to Nairobi by railway line and by road transport. The Thika-Nairobi road was first constructed around 1902. It is also worth noting that the pineapple and sisal plantation which were established around Thika town between 1904-1920, was largely due to accessibility of this area to Nairobi. This was mainly due to the fact that the crops grown by the white settlers were mostly meant to go to the export market.

The rail transport system favoured and enhanced marketing of produce, acquisition of agricultural inputs and cheap labour to work on the farm.

2.8.5   The Existing Road Transport Systems of Thika District in Relation to Agriculture

In order to present a thorough discussion of the influence of the rural road transport on agricultural development in Thika District, it is important to have an

overview of the present transport system in the district.

The dominant mode of transport in the study area is road transport. This forms the most extensive network when compared to the railway network. The railway line branch from Nairobi to Nanyuki passes through Thika District. This is one of the earliest mode of transport and was completed at around 1937.

The spatial structure of the road transport network reflects two differing regions in Thika District. The highlands especially in Gatanga, Gatundu and Kamwangi divisions have a relatively dense network of road transport comprising all the types of road surfaces. The low land areas particularly Thika and Kakuzi have low density of road networks. Incidentally, the road network density seem to correspond to the intensity of agricultural activity in Thika District. In particular most of the areas with high levels of agricultural activities tend to have high density of transport networks.

The road transport networks have a heavy bearing on the drainage pattern. Most of the roads have been constructed parallel to the numerous rivers that run from Aberdare mountains and flow Eastward and then Southwards to join Tana River. As a result of this, many ridges are cut from each other since roads construction across the ridges is avoided as it would involve and necessitate construction of numerous bridges. Given the limited resources, these roads have not been constructed, as a result of which villages and farm households are afforded differing levels of accessibility.

2.8.6 Relationship Between the Road Transport and the Trading Sector in Thika District

The trading sector in Thika District relies heavily on the transport networks. Given that most of the population in Thika District reside in rural areas, and derive their living in agricultural related activities, the surplus produce from the farm need to be delivered to the urban markets. These markets are located along the major rural roads.

The leading and largest urban centre is Thika Town which is also the district head quarter. Several other retail markets are spatially distributed in all the six divisions of Thika District. These market centres are all served with good road networks.

The trading sector in Thika District is therefore dependent on the transport infrastructure. The condition of the transport infrastructure has therefore played an important role in promoting the trading sector in Thika District. It is also worth noting that most of the trading centres in Thika District are located at nodal point or point of intersection of the major rural roads.

2.8.7 The Role of Agriculture in Rural Development

Agriculture has played an important role in the development of rural areas in Kenya. In rural areas agriculture is the dominant activity and therefore the performance of the agricultural activities will directly influence the pace of development in these areas.

In Kenya, for instance, the share of agriculture in the Gross Domestic Product has been overwhelming over the years, compared with the other major sectors of the economy. Since Kenya attained independence and even before, agriculture has been the mainstay of the economy, contributing a significant share of the Gross Domestic Product and absorbing over seventy percent of the labour force.

Given that agricultural activities are rural based, any discussion of these activities in relation to development must focus on the rural sector. In this section we are mainly concerned with the role of rural transport infrastructure in agricultural development.

In Kenya like in many other developing countries, the rural sector has not experienced the desired levels of development, owing to various inhibiting factors. The chief factors stem from an inadequate infrastructure to support the growth and development of agricultural activities. Other factors include climatic variability, reliance on one cash crop, lack of modern agricultural inputs among others.

That Kenya is an agricultural oriented economy is based on the fact that over 80 per cent of the population, live in the rural areas and derive their earnings from the agricultural sector which is rural based. Furthermore, the agricultural sector contributes the largest share of the Gross Domestic product of our economy. The performance of the agricultural sector is therefore crucial in attaining desired levels of rural development in our country.

2.8.8 Human Infrastructure

Human resources play an important role in the development of a region. Economists contends that it is the human resources that determine the capacity, character and pace of economic development (Todaro, M.P 1985).

Thika District is endowed with a high population which has been instrumental in the development of the region. The population is highly literate with adult literacy rates of about 60 percent. This is a relatively high figure compared with the average national adult literacy levels of 54 percent. The high level of literacy has some implications on agricultural development and thereby rural development. For instance, literate small scale farmers have a high probability of adopting new farming techniques and innovations through agricultural extension services.

The District is catered well with a number of education institutions which have played a crucial role in the development of human resources. There are numerous primary schools distributed all over the District. Secondary schools are also available, although they are not adequate to meet the requirement of primary school leavers.

The district has one national middle level technical institute to cater for the training of technical manpower in various trade aspects such as carpentry, plumbing mechanics, engineering among others. The District has one international university located near Thika Town.

2.8.9 Nature and Status of the Roads

Trunk roads passing through the District are in good condition as they were re-carpeted recently. On the other hand primary roads, secondary roads and rural-access roads in the district are in poor condition due to lack of maintenance. Most of the secondary and minor roads are in very bad condition and are impassable during the rainy season. This has been one of the major obstacles in the development of the rural sector in Thika District. It has also significantly affected the delivery of agricultural inputs into the rural areas of the District.

Given the importance of Thika district in terms of agricultural activities, there is need for improvement of these roads into all weather roads standard. This is because during wet season tea delivery to factories is delayed or completely hindered because the roads are impassable. Horticultural products from small scale farmers are delayed before they reach the market during the wet season. The table below shows distribution of roads and class in Thika District.

Table 2.8:   Distribution of the Roads in Thika District by Class and Length in Km^2 Road Density

Division	Classified Roads	Bitumen	Gravel	Earth
Gatanga	224.7	43.8	146	34.9
Gatundu/Kamwangi	377.3	136.2	121.9	119.2
Kakuzi	167.6	50.8	107.5	9.3
Ruiru	185.6	80.8	83.1	21.7
Thika	77.6	51.9	24.7	1.0
Total	1032.8	365.5	483.2	186.1

Source: Thika District Public Works Office (1998).

From the table above it is apparent that the density of road network is high in Gatundu Kamwangi, Gatanga and parts of Ruiru Divisions. Although there is good coverage of road network in these areas the state of the roads is poor. Yet there is potential in these areas for further development especially in the agricultural sector which suffers from poor transport during the wet season, when the roads become virtually impassable. In Kakuzi, Ruiru and some parts of Thika Districts the road network is very poor despite the fact that the latter two divisions have some roads with bitumen surface. This is evidenced from the road density table provided in the preceding section.

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CHAPTER THREE

METHODOLOGY

3.0 INTRODUCTION

Geographic field investigations can encompass large areas as well as areas that have a wide variety of spatial phenomena. It is therefore, not possible to comprehensively investigate every occurrence of a phenomenon within the area of study. It is too costly and time consuming to interview every potential respondent in a field study.

In order to bring problems down to more manageable proportions a small percentage or a sample of the total area was selected for this study which covered Thika District. The relevant samples were drawn from the large body of data or the population.

The techniques of data collection and analysis employed in this study were determined by various factors. These include, the objectives of the study, the area of coverage and the range of data on socio-economic variables that were to be studied and examined in the statistical analysis.

Qualitative and Quantitative analysis were used in the study to establish essential facts, perform tests of hypothesis and enable relevant conclusion(s) to be drawn.

Initially, a comprehensive literature review was attempted with the purpose of extracting essential information from available secondary sources and to avoid duplicating what has already been done.

3.1 RESEARCH DESIGN

In the study, reconnaissance spatial sampling was conducted first, this was done using relevant documented secondary data from the study area. The secondary data for this purpose was obtained from base maps of the study area especially topographical maps obtained from the Survey of Kenya.

The sampling procedures used in the study were determined by various factors. In selecting the samples for the study of the impacts of the feeder roads on household farm economies, Systematic and linear sampling procedures were employed. This was found appropriate because sampling units were taken on basis of their location from the main feeder road. Samples for the rural trading and market centres for the study of the relationship between accessibility of these centres and the structure of non farm economic activities were obtained through hierarchical sampling. This was purposely done to reflect the different sizes of the market centres.

Field physical observations were also made by the researcher to gather information relevant to the objectives of the study. In the field, physical observations were made on the land use patterns, especially horticultural land use among the small scale farmers located near the main feeder road. Field physical observations were also made on road side business activities along the rural roads in the study area. These observations were made and recorded in the field note book and were later used in data description and analysis.

3.1.1 Universe

The universe or the area of study covered Thika District. This is where the samples for the study were drawn using various spatial sampling techniques.

3.1.2 Spatial Sampling Design and Procedure

The specific samples for this study were drawn from the universe using spatial sampling procedures to ensure representative samples.

Samples for the study of the impacts of the feeder road on farm gate prices of french beans and on commercial horticultural land use were collected within a zone extending 8 km on either side of the road facility. This was found to be appropriate given that the zone of influence of the road does not extend further than this in the area of study as there are other feeder roads running parallel to this. This was also purposely done to avoid a situation that would give rise to overlapping of the zone of influence of the road with other feeder roads. Sampling points were then selected within a framework of three zones based on distance from the feeder road facility.

1. Households farms located adjacent to a road or within two kilometres distance from the road.

2. Between two and five kilometres distance from the road.

3. More than five kilometres distance from the feeder road.

Systematic and linear sampling techniques were employed in selecting the sampling areas and points. Topographical maps 1:100 000) for the study area and cadastral maps were obtained from the Survey of Kenya, This aided in selection of the sampling areas and points.

The actual respondents in each sampling points were then randomly selected with 40 respondents being selected in each zone and a total of 120 respondents were interviewed.

In studying the influence of the rural roads on the location, growth and development of non farm economic activities, (Roadside business activities) the roads were purposely selected in each of the administrative division of the district to reflect on both road surface quality and connectivity characteristics.

The rural trading and market centres for the study of accessibility in relation to the structure of non farm economic activities were selected by hierarchical spatial sampling in each of the division in the district. In this selection five principal trading centres in each of the division were listed. There after, at least two major centres, located adjacent to principal roads were then selected . In total, ten trading centres were selected for detailed study. However, this was done after first locating the major roads. This was purposely done to derive essential facts regarding the relationship between accessibility and non-farm economic activities. Furthermore, it was only in these centres where secondary data required for this analysis was documented.

3.1.3 Data Requirement

A wide range of data was required for this study in order to test the formulated hypotheses. Data was required on various socio- economic variables of the household economies such as the size of land, the size of land used for horticultural activities, farm gate prices of french beans, sex of respondent, income etc.

Data was also required on the categories of non-farm economic activities in various rural trading and market centres within the district. These non-farm economic activities include, tertiary activities such as insurance, banking, postal services, and *Jua Kali* activities. In order to compute accessibility indices secondary data was obtained from published materials especially topographical maps from the Survey of Kenya.

3.2 SOURCES OF DATA

In order to collect adequate data for the study, it was found necessary to consult various sources. The data collected was required to test the hypothesis formulated in this study.

3.2.1 Primary Data

Primary data refers to the sort of information that was collected first hand in the fieldwork. This was done using questionnaires and field physical observations. The primary data for this study was obtained from field survey conducted by the

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researcher with the help of two research assistants. For this purpose, questionnaires were used. Two different types of Questionnaires were used to collect Primary data on socio-economic variables of the households which were relevant in testing of the hypothesis of this study.

The questionnaires used were both the open ended and closed ended. However, more reliance was made on the use of closed ended questions to allow for computer data entry and analysis. In order to make this effective the answers to the questions were coded and a code sheet was prepared using the information provided in the answer sheet.

3.2.2 Secondary Data

Secondary data refers to the data which was obtained from published sources such as official statistics, maps, aerial photographs or those gathered by some agency other than the researcher.

The secondary data used for this study was obtained from topographical base maps covering Thika District, Government offices, and from other published material for the study area. For instance, the data on development variables were collected from the District statistics office, District public works office, and the District agricultural office.

Data on accessibility of various trading and market centres under study was obtained from topographical maps of the district. Secondary data was also obtained from the District Development Plan for Thika District (1997-2001).

3.3 TECHNIQUES OF DATA COLLECTION

3.3.1 (a): Collection of data on farm gate prices of French Beans and commercial horticultural land use among small scale farmers

A set of questionnaire with both open ended and closed questions was administered to the households selected according to their proximity to the feeder road facility studied. Due to the large area traversed by the road under study, namely Thika- Kirwara road, the households interviewed were selected mainly from the middle agro-ecological zones. However, several households from different villages located at varying distances from the road on either side were interviewed.

A wide range of socio-economic data was collected from the households through the questionnaire administration. Data was collected on price of agricultural commodities, Quantity of output sold and size of land under commercial horticultural farming, among others. Only one road was selected and studied in detail due to the numerous roads in the study area. This road was found to be an appropriate representation of other feeder roads in the area as far as the influence of accessibility on farm gate prices and horticultural land use is concerned.

(b): Collection of Data on Commodity Prices in major Retail Markets in the

Study Area and Agricultural Land-use

The data on retail prices of the selected commodities in the major retail markets in

Thika District was collected, from the district agricultural office. This data was

obtained from the district annual reports, published by this office.

3.3.2: Collection of Data on Distance of the Household Farms From the

Feeder Road

Data relating to the distance of the household farm from the feeder road facility

under study was obtained from topographical maps of the study area. A special

map on a scale of 1: 100,000 covering Thika District only, was obtained from the

Survey of Kenya. This map rendered the computation of these distances an easy

task and measurement errors were minimised. Measurement of the distance was

achieved effectively using relevant scales provided in the maps.

3.3.3: Collection of Data on the Influence of the Rural Roads on the Location, Growth and Development of Roadside Non Farm Economic Activities:

A Questionnaire was used to collect data that was employed to examine the influence of the rural roads on the location, growth and development of the roadside non-farm economic activities. Only six types of roadside business activities were studied in detail. The Questionnaire used had both closed and open ended Questions. However, most of the Questions were closed ended. This was purposely done to ensure easy analysis of the data collected using computer facilities. This required coding the answers appropriately.

The Questionnaire used was designed to collect data on a wide range of socio-economic variables relevant to this study. Data was collected on the type of roadside business activity, income in Kenya Shillings from the business per year, sex of the Business owner, age among others. A coded sheet was finally used to enter and record the data gathered by this questionnaire.

The Questionnaire was administered to the owners of the roadside businesses. The roads were purposely selected to reflect surface quality, length and connectivity characteristics. The respondents were selected through systematic sampling along these roads. By this is implied a procedure by which the respondents were selected at some regular interval. That is respondents were selected after every 2km along the road. In total 108 respondents were interviewed during the month of January 1998. On average at least 15 respondents were interviewed in each of the 6 divisions in the district.

3.3.4 Collection of Data on Accessibility of Rural Trading and Market Centres and the Structure of Non Farm Economic Activities in these Centres

The transport network map of Thika district comprising the classified roads provided the data required for computing accessibility indices of the rural trading and market centres. The transport network map was obtained from the Department of Resource Surveys and Remote sensing, under the Ministry of Planning and National Development. This map was useful for the technique of network analysis used in this study to compute accessibility indices.

Data pertaining to the structure of non-farm economic activities in the rural trading and market centres was obtained from Thika county council, lists of licensed business in all the trading centres within the jurisdiction of the county council. The updated list for the year 1997 was used. This data was supplemented from other data obtained from the District Trade Office. This data included trade licenses issued to traders in the respective trading and market centres within the district.

3.4 TECHNIQUES OF DATA ANALYSIS

The techniques of data analysis which were employed in this study were based on the hypothesized relationships and the objectives of the study. Both qualitative and quantitative techniques of data analysis were used in the study.

3.4.1 Qualitative Analysis

Qualitative techniques of data analysis were used to summarise and to present the data in an organised manner. This was found to be useful to enable appropriate interpretation of the data collected. Qualitative techniques were also used to analyze data which was at ordinal scale of measurements. Some of the data collected was also mapped. This was useful in summarising data which if written would have required several pages to describe. The maps were also useful in locating places mentioned in the study.

3.4.2 Quantitative Analysis

Quantitative techniques of data analysis were used specifically to test the strength and validity of the hypothesized relationships. Unlike the qualitative data analysis techniques, these techniques permitted the researcher to conduct significant tests on the hypothesized relationships at a given significant level, and to draw conclusions from these tests.

3.4.2.1   Analysis of Data Relating to the Farm Gate Prices of French Beans and the Distance of Household Farm to the Feeder Road

(a) Pearson's Product Moment Correlation Analysis

This technique was used to determine the degree of association among the variables under investigation. Linear correlation analysis was undertaken to

establish the degree of association between the variables of interest. Correlation coefficient was computed for the relevant variables to determine their strength or degree of association.

(b) The Simple and Multiple Linear Regression Model

These techniques were employed in this study to analyze the relationship hypothesized between proximity of household farm to the feeder road facility and the respective farm gate price of french beans. The household farm size was also included as an independent variable in the model. This technique was used to determine the strength of the relationship using the R squared value obtained. The "t" and "F" tests were then calculated to allow a higher level of interpretation of the relationship at a certain level of significance. The simple linear regression model was used to investigate the relationship between distance of household farm to the feeder road facility studied and the farm gate prices and was of the form.

$$Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i$$

Where: Y_i = Farm gate prices of french beans.

β_0 = Constant.

β_i = Intercept.

X_i =   Independent variable or the distance of household farm to the feeder road.

ε_i = the error term.

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This form of the model implies that there is a one way causation between the variables Y and X, that is proximate to the road is the cause of changes in the farm gate prices.

The parameters of this function are β_0 and β_1 and the aim of the study was to obtain estimates of their numerical values β_0 and β_1. Regarding the sign of β_1 it was expected to be negative given that the most accessible household farms were hypothesized to get better farm gate prices. The above simple linear regression model was extended to multiple regression by adding one more explanatory variable which was the quantity of the french beans produced and sold by the household. The multiple regression equation after the additional explanatory variable was of the form:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \varepsilon_i$$

Where as before:

Y_i = farm gate prices of french beans

β_0 = constant (parameter estimate of the intercept)

β_1 = parameter estimate of the first explanatory variable (distance of household farm from the feeder road).

β_2 = parameter estimate of the second explanatory variable (quantity of French bean produce).

ε_i = the error term or the random disturbance term in the regression model.

In this model, it was assumed that the relationship between Y, X_1 and X_2 was linear:

$$Y = f(X_1, X_2)$$

Like in the previous model this form of regression equation assumed a one way causation between variables Y and X_1, X_2

The distance of household farm from the feeder road and the quantity of french beans produced by the household are the cause of changes in farm gate prices of french beans.

The parameters of the above multiple regression equation are therefore b_0, b_1, b_2 and the aim was to obtain estimates of their numerical values of $\hat{b}_0$, $\hat{b}_1$ and $\hat{b}_2$.

The test of goodness of fit using R^2 and the analysis of variance was then undertaken to test the overall significance of the regression line or the parameter estimates.

3.4.2.2   Analysis of Data Relating to Accessibility of Retail Markets and Commodity Prices.

(a) Person's Product Moment Correlation analysis

Correlation analysis was used to establish the degree of association between the commodity prices in the respective retail markets and their accessibility index. This was to determine if variations in price of the agricultural commodity in each of the retail markets could be attributed to the accessibility scores of these markets.

(b) Simple linear regression

This technique of data analysis was used to establish if there was any functional relationship between accessibility scores for the retail markets and the prices. For this purpose one commodity was selected namely green bananas whose price unit was in bunches.

3.4.2.3 (a): Analysis of Data Relating to Distance of Household Farms to the Feeder Road and Horticultural Land use

(i) The simple and multiple linear regression:

The simple and multiple linear regression model was also used to analyze the hypothesized relationship between households' farm proximity to the feeder road and the size of land under horticultural farming. In this respect, the distance between the households farms and the feeder road facility under investigation on the one hand and the size of households farms on the other were used as the independent variables to explain the proportion of the household farm under horticultural farming. The simple linear regression model was first used to analyze the relationship with only one explanatory variable, namely the distance of household farms to the feeder road. The student "t" test and the "f" analysis of variance (ANOVA) were later conducted to test the overall significance of the regression line.

(ii) Location Quotient

The location quotient technique was used to analyze data on land use in Thika district. Data for this purpose was analyzed for four types of land uses in the district namely, coffee, Tea, Banana and other horticultural crops. In this case the four types of land use were analyzed according to their divisional distribution in Thika district using Location quotient technique. The location quotient results were also compared to the road density per division in order to give the relevant interpretation concerning any relationship between the L.Q. and the road density.

$$\text{Location quotient} = \frac{\text{Percentage of district land use in crop i in region j}}{\text{Percentage of division land use in all crops in region j}}$$

(b): Analysis of Data Relating to Road Density and the Proportion of Land Under High Value Cash Crops in the Study Area.

Product moment correlation analysis was employed to determine the degree of association between road density and the proportion of land under high value cash crops in each of the six divisions in the district.

3.4.2.4 Analysis of Data Relating to Location and Growth of Road Side Non-Farm Economic Activities

Descriptive statistics were used to analyze the data collected on roadside non farm economic activities. Frequency tables and histograms were used to summarise this data so as to allow the necessary interpretation to be made. The measures of

central tendency were also used in analyzing the data which was collected through the social survey.

Statistical tables and diagrams were also found relevant in analyzing this data collected from 108 respondents.

3.4.2.5 Analysis of Data Relating to the Accessibility of Rural Trading and Market Centre and the Structure of Non-Farm Economic Activities

(a)   Pearson's Product Moment Correlation analysis was used to determine the relationship between accessibility indices for the rural trading and market centres on the one hand and the size of non farm economic activities in these centres.

(b)   Descriptive statistics were also used to summarise the data collected so as to make the relevant interpretation regarding the relationship between accessibility of the trading and market centres and the structure of selected non-farm economic activities.

(c)   Network Analysis

The technique of network analysis was used to derive measures of accessibility for selected market centres in the study area. Network analysis permits a more objective means of measurement and interpretation of route systems. A number of measures have been proposed to provide simple representations of network

structure. Many of these measures are derived from simplification of actual maps whereby route systems are reduced to graph forms. The graphs are composed of a series of points/vertices with lines indicating which places are connected.

Three parameters are employed to obtain the connectivity indices, namely the beta, alpha and gamma index. Beta, index relates number of edges in the system to number of vertices. Alpha measures the ratio between the observed number of circuits and maximum possible number of circuits.

Gamma measures the ratio of the observed number of edges to the maximum possible number. Accessibility for these markets was measured using a connectivity matrix, wherein distances between all pairs of nodes in the topological road network were expressed in terms of the number of edges along the shortest paths connecting them. More realistic measures of accessibility were further derived using actual distances between the market centres. The accessibility indices derived were then analysed in relation to the structure of non farm economic activities in these centres so as to derive the nature of the relationship.

3.5 Methods of Data Presentation

3.5.1 Maps

Two broad groups of maps were used in this study. Those showing qualitative and quantitative data.

(a) Qualitative Maps

These maps were used to locate data measured on a nominal scale. The information that they show distinguishes different categories of phenomena with no indication of quantities, amount or relative value.

(b) Quantitative maps

The main objective of using quantitative maps in this study was to show quantity as well as kind and location of phenomena. These maps were used to represent interval and ratio data.

The above two categories of maps were prepared for the study based on the physical topographic maps prepared by the Survey of Kenya. Maps were also prepared with inputs from the field survey and other accumulated data from secondary sources. Maps are important in geographic studies for they enable the results of a field survey to be displayed in a form which allows them to be interpreted in a precise manner. Maps used in this study permitted the spatial variables to be presented in their context. Examples of some of the maps used in this study include Road Network Map, population density map, among others.

3.5.2 Statistical Tables and Diagrams

Statistical tables have been used in this study to summarise the field data collected. These tables are in form of frequency tables, barcharts or ordinary statistical tables. These tables were found useful in presenting data in organised form, for easier reading and making appropriate and relevant interpretation.

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CHAPTER FOUR

FEEDER ROADS AND AGRICULTURAL DEVELOPMENT IN THIKA DISTRICT

4.0 INTRODUCTION

This chapter discusses the relationship between feeder roads and agricultural development in Thika District. In order to study the relationship between the feeder roads and agricultural development in detail a certain feeder road in Thika District, namely Thika - Kirwara road was selected for detailed study. This is a major feeder road in the study area and serves many people in the outlying rural areas. There after, this road facility was related to certain growth indicators in the rural economy. The purpose of undertaking this analysis was, among others to determine the extent to which the influence of the feeder road was felt in the rural economy. In particular, the influence of the feeder road on horticultural farming activity and on farm gate prices of an agricultural commodity was investigated.

The relationship between agricultural land use in Thika District and road transport networks was also examined. The location quotient technique was used to determine concentration and distribution of the main types of land use in the district in relation to road density in each of the six administrative divisions. In this study road density is defined as the total classified road network per square kilometre.

On the basis of the available data which was collected from primary and secondary sources, a detailed description and analysis of the role of feeder roads in agricultural development was attempted. In this perspective, agricultural development is distinguished

from rural development although the former is considered as an important component of the latter.

4.1 RELATIONSHIP BETWEEN FEEDER ROADS AND AGRICULTURAL DEVELOPMENT WITH SPECIAL REFERENCE TO THIKA DISTRICT

According to 1997 population projections, 86 percent of the population in Thika District live in the rural areas. Majority of these people are engaged in agricultural activities. For instance, most of the working labour force are employed in their own farms as small scale farmers or are employed in other large farms within Thika District as farm workers.

The agricultural sector in Thika District supports many agro-based industries located in Thika Town. These includes; Fruit processing factories, Coffee and Tea processing factories, Textile industries among others. Thika town is one of the most important urban centres in Kenya in terms of manufacturing activity.

The main traditional cash crops grown in Thika district over the years have been coffee and tea. These crops are grown under the small scale farm sector and involves small scale farmers who own small parcels of land ranging from 0.5-2 hectares. However, there is a spatial variation in the average size of land owned by these farmers. In Gatanga for instance, small scale farmers were found to own parcels of land with an average of 0.5 hectares. In Kakuzi and Ruiru divisions, the average size of land holding is relatively high as the large scale farm sector is located in these areas. The large scale farm sector grows coffee in large plantations. However, the largest share of coffee output come from the small scale farmers. These farmers are organized into coffee societies and co-operative

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unions for purposes of marketing. Thika district contributes a significant share of coffee output in the country.

The development and growth of the coffee industry in the study area can be linked to transport networks and climate. Thika District has some of the oldest coffee plantations some of which were planted as early as 1920's. This early establishment of coffee plantation was linked to the relative accessibility of the district to major markets.

The delivery of coffee produce to coffee factories is greatly influenced by the condition of the road. The delivery of coffee to coffee factories has been an obstacle to coffee farmers in Thika district especially during wet seasons. This has necessitated the use of human head loading and back loading particularly by women in delivering the coffee berries to factories. Given this condition the improvement of the existing road network is indicated especially the minor roads and access road. This would go along way in reducing time and energy taken in delivering the coffee berries to the factories.

LEGEND

--·--·-- District Boundary
_____ International Trunk Roads
— — — Primary Roads
_____ Minor Roads
—·—·— Secondary Roads
············ Zone Boundary
|||||||| Forest

T Tea
C Coffee
H Horticulture
M Maize
P Pineapple
S Sunflower
R Ranching

N

0   5   10   15 Km
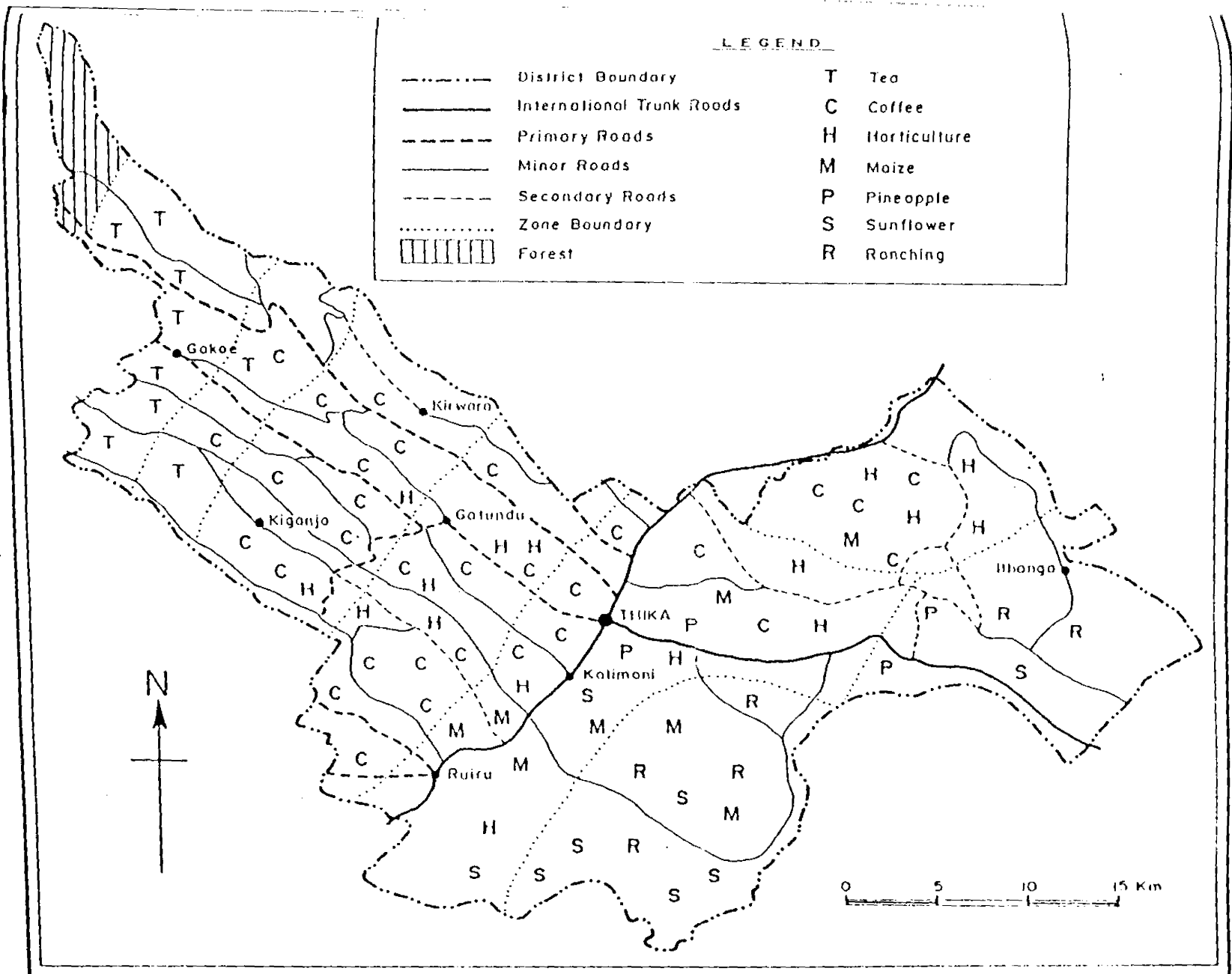
Figure 4.1A map showing major agricultural crops and transport patterns in Thika District

Source: Compiled by the Researcher from Thika District Development Plan, 1997-2001

As mentioned earlier, tea is also one of the major cash crops in Thika district. Tea is produced in higher altitudes of the district especially in Gatanga, Kamwangi and Gatundu divisions due to favourable climatic conditions such as rainfall, temperature e.t.c. The main obstacle in tea production lies largely in the transport system, especially during wet season. Tea delivery to factories is hindered due to impassable roads. The impact of this include reduced quality of tea due to deterioration emanating from delays in delivering it to the factories in time. This translates to reduced income to the small scale farmers.

In order that effective tea production and delivery of the produce to the factories is attained there is an immediate need to improve the conditions of roads especially the weather roads to an all weather standard. This will greatly reduce the problems of transport faced by the farmers at the local levels.

Figure 4.1 below shows the major agricultural crops and the major road transport networks in Thika district. From this map, there is strong evidence which shows that other than climate, horticultural farming has a clear preference to road facilities. More horticultural crops seem to be grown around the main roads passing through Thika district. In particular pineapple plantation and cut flowers are located near the principal roads passing through Thika District

4.1.2 The Horticultural Industry in the Study Area.

One of the primary objective of this study was to determine the extent to which the feeder roads influence commercial horticultural land use in Thika District. It is therefore necessary first to describe the nature and status of the horticultural industry in Thika District.

The horticultural industry in Thika District is relatively well established compared to other district in Kenya. A number of factors are responsible for this including its relative accessibility to major urban centres and its proximity to the capital city.

The wide range of climate and soils in the study area aided by irrigation, allow many horticultural crops to be grown profitably on commercial and on home consumption scales. Horticultural farming activity is the third most important agricultural activity in the study area in terms of income earnings to the farmers. It is only second to Tea and third to Coffee. Given this picture horticultural activity is an important economic activity in the rural economy of Thika District. However, there is lack of adequate economic data to permit a rigorous quantitative assessment of its component and overall position.

The horticultural industry in the study area is both under the large scale farm sector and under the small scale farm sector. The small scale farm sector contributes the largest share of horticultural products in the district. On the other hand the large scale farm sector dominate in the production of pineapples and cut flowers. Whereas, the small scale farm sector dominates in the production of other horticultural products such as vegetables and nuts, including avocadoes, french beans and passion fruits.

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There are three factories for processing horticultural products within the study area These are:

- The Kenya Canners factory owned by Del monte (K) Limited - a company which process pineapples for the manufacture of pineapple juice, jam and salad.

- The Kenya Fruit processors factory is also located in Thika town. This factory processes fruits of various types especially passion fruits, plums and pears.

- The remaining third factory is located at Kalimoni/Juja and deals mainly with processing of passion fruits and other temperate fruits grown on the highlands along the Aberdare mountains.

The dominance of horticultural industry in Thika District can be attributed to various factors. The chief factors include its proximity to major urban market centres of Nairobi and Thika. Its relative accessibility to agro-processing industries and good climate enabling the cultivation of a variety of horticultural crops. Table (4.1) below shows the types of horticultural crops that were grown in Thika District during the year 1997.

Table 4.1 shows the crops that were specifically grown for commercial purposes by small scale farmers in the District. From this table there is strong evidence to suggest that horticultural farming activity is an important economic activity in the study area to warrant a detailed study.

Table 4.1   Commercially Produced Horticultural Crops in Thika District 1997

VEGETABLES	FRUITS	NUTS	CUT FLOWERS
Asparagus	Avocadoes	Macadamia	Roses (But numerous species and varieties are grown)
Beans	Bananas		
Broad			
Green	Citrus fruits		
	Grape fruit		
Brassicas	Limes		
Broccoli	Oranges		
Brussel sprouts	Mangoes		
Cabbage			
Cauliflower	Melons		
Kale	Sweet		
	Water		
Onions			
Bulb	Passion fruit		
Green	Pineapples		
Brinjals			
Capsicum			
Carrots			
Celery			
Chilies			
Potatoes			
Sweet potatoes			
Tomatoes			
Peas			

Source: District Horticultural Crops Officer, Thika District and Horticultural Development Authority 1997.

At the National level, horticultural industry is also becoming an important source of foreign exchange. For instance, in the last three years horticultural industry has been placed third in terms of foreign exchange earnings in the study area. As indicated earlier it is only second to coffee and tea.

The growth and development of horticultural industry in the study area therefore places it in a position to contribute significantly to:

(a) Improving nutritional standard.

(b)   Increasing rural incomes and employment opportunities.

Horticultural products are an important source of vitamins in diets of small scale farmers in the study area, heavily dependent on grains and beans. Increased incomes arising from expanded horticultural production on small holdings would be equitable in income distribution terms and would also help alleviate rural poverty.

Horticultural activities are regarded to be important in contributing to employment within agriculture from the stand point of existing work opportunities and in its capacity to create additional ones and help in reducing seasonal under employment. All of these contributions stem from the fact that horticultural activities generate labour intensive work and therefore absorb a considerable number of labour force. For instance cut flower plantation in the study area employ many workers especially during picking and sorting. Furthermore the important processing, marketing and input-supply linkages that

horticultural production has with other sectors of the economy mean that any increase in horticultural output will also have beneficial effects on aggregate output and employment

The performance of horticultural industry in Thika District has however been affected adversely by the condition of roads. It is claimed that poor road transport in terms of improvement and network affects the growth of horticultural industry. This, it is claimed, is because horticultural products are perishable commodities and require to be delivered to points of consumption immediately or without undue delay. Delays in delivery of export products to the airport affects their quality and hence the income earnings to the farming community.

In the recent past the growth of horticultural industry in Thika District, especially the introduction of cut flower growing in plantations and in small scale farms along major rural roads has created numerous employment opportunities. This has also been the case with french beans cultivation. These activities are labour intensive in nature and given their location in rural areas, they have been instrumental in easing pressure from agricultural land by providing employment opportunities to people in the rural areas.

4.1.3 Transport and Commercialization of Agriculture.

Transport networks have an important role in the commercialization of agricultural activities. With improved transport in rural villages it becomes possible for the farming community to produce commercial cash crops such as the horticultural crops cited above.

Thika District has a considerable proportion of its land under commercial cash crops. The existence of this activity is aided by good transport infrastructure and a dense

network of road transport facilities, especially in the higher and middle agro-ecological zones of the district.

The importance of commercial agriculture in rural development cannot be over emphasized. Commercial agriculture aids the small scale farmers in earning cash income. The income entering the farming communities in the villages will then rise with the development and growth of commercial agriculture. This is a crucial aspect in attaining the overall objective of raising the levels of living in the rural economy.

In Thika District, agricultural activities have become increasingly commercialized in the recent past with introduction of new crops, grown for the export market such as French Beans. This has ensured that small scale farmers in the rural villages cultivating this crop get cash immediately they sell these crops. Of crucial importance in aiding this activity has been the nature of road transport facilities in the study area. The road transport facilities have aided the commercialization of agriculture in the study area, since they are relatively good and a relatively fair degree of accessibility is afforded. However the influence of climate is also crucial in determining land use patterns.

4.2 Data Analysis I

4.2.1 The Influence of the Feeder Roads on Horticultural Land use and Farm Gate Prices of French Beans among the Farming Community in the Study Area

One of the primary objectives of this study was to determine the influence of the feeder roads on agricultural land use. Specifically, the study sought to examine the extent to which household farms' proximity to feeder road affected horticultural land use. The study also sought to examine the influence and impacts of the feeder roads on farm gate prices of french beans.

In an effort to study this effectively, a certain feeder road in Thika District was selected for detailed study. For this purpose, the Thika- Kirwara road, the main feeder road in Gatanga Division and the outlying areas was selected. This road extends for approximately Twenty seven kilometres and passes through different agro-ecological zones. In studying the influence of the road on agricultural land use and on farm gate prices, three zones of influence were identified:

(a)   0-2 km zone on either side of the road

(b)   2-5 km zone on either side of the road

(c)   above 5 km zone on either side of the road

Households were selected for administering of the questionnaires on the basis of their location from the feeder road. The methodology used is provided and detailed in the

(ii)   The hypothesised relationship between horticultural land use and the distance of the

         household farms from the main feeder road facility studied

In what follows, we concentrate on data analysis on the influence of the feeder road facility

(studied) and the farm gate prices of the agricultural commodity investigated,

namely french beans. We also present data analysis on the influence of the feeder road on

horticultural land use in the study area.

         Data for this analysis was collected from 120 respondents. The data collected was

analyzed using SPSS PC+ computer package. The data was entered in the computer and

various statistical analysis were conducted.

4.2.2 Frequency Tables

Frequency tables were used to present and analyze the data collected from the 120

respondents. There were 17 variables that were analyzed. The use of frequency tables

was to aid in summarising the data to make meaningful interpretations from the field survey.

It should be noted that only the relevant variables were presented in form of frequency

tables.

         The respondents were asked to state their primary occupation. Two major options

were provided namely, non-farming activities and farming activities. From the data

collected from the field survey 79.2 per cent of the respondents were farmers while the rest

were occupied in non-farm economic activities.

         The frequency table below shows the result of the data obtained on this variable.

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Variable 2   Primary Occupation

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Farmer	1	95	79.2	79.2	79.2
Non-farm	2	25	20.8	20.8	100.0
TOTAL		120	100.0	100.0	

In the field survey, the respondents were asked to state the size of their land holding in hectares. The average size of the household farmland holding was found to be 1.5 ha.

Regarding the type of land ownership 84.2 percent of the respondents indicated that they held freehold title deed to their land. On the other hand, 12.5 percent had leased land and 3.3 percent indicated ownership through other means.

The frequency table below summarises the above results.

Variable 4 Ownership of Land

Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Freehold	1	101	84.2	84.2	84.2
Leasehold	2	15	12.5	12.5	96.7
Others	3	4	3.3	3.3	100.0
TOTAL		120	100.0	100.0	

The respondents were also asked to state whether they grew horticultural crops in their farms. It was interesting to find that all the respondents interviewed indicated that they cultivated horticultural crops in their farms.

The frequency table below shows the result of the field survey on the above variable.

Variable 5 Growing of horticultural crops.

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Yes	1	120	100.0	100.0	100.0
	TOTAL	120	100.0	100.0	

In the field survey, the respondents were also required to estimate the proportion of their land under french bean crop, a dominant horticultural crop grown for export, in the study area. This ranged from 0.1 hectares to 2.5 hectares. When asked whether this crop was grown under irrigation or rain fed water the respondents gave the following information which is provided in the frequency table below.

Variable 8   Source of water for cultivation of French beans

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Irrigation	1	84	70.0	70.0	70.0
Rain fed	2	36	30.0	30.0	100.0
	TOTAL	120	100.0	100.0	

From the above frequency table 70 per cent of the respondents cultivated the french beans under irrigation while 30 per cent of the respondents indicated that they cultivated the french beans under normal rain fed water.

The respondents were asked to give an estimate of the output in kilograms of their french beans produce per month. The lowest amount of produce given was 150 kg and the highest was 2500 kg.

When asked to state the purpose of cultivating the french beans produce the answers given by the respondents indicated that 66.7 per cent of the respondents grew the crop purposely for sale and consumption. The rest comprising 20 per cent of those

interviewed cultivated the crop purposely for consumption The frequency table below summarises these findings.

Variable 10 Reason for growing horticultural crops

(sale/consumption)

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Consumption	1	24	20.0	20.0	20.0
Sale	2	80	66.7	66.7	86.7
Sale and consumption	3	16	13.3	13.3	100.0
TOTAL		120	100.0	100.0	

The french beans produced by the small scale farmers were sold to middlemen and export companies as is evidenced from the result of the field survey. 50.8 per cent of the respondents sold the french beans produce direct to the middlemen while 39.2 per cent sold their produce to exporting companies. The result of the field survey on these variables are presented here below in form of frequency table.

Variable 11   Buyers of french beans produce

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Middlemen	1	61	50.8	50.8	50.8
Export companies	2	47	39.2	39.2	90.0
Others	3	12	10.0	10.0	100.0
TOTAL		120	100.0	100.0	

The respondents were also required to state whether the french beans produced were collected at collection centres or at the farm. 73.3 per cent of the respondents indicated that their produce was collected at designated collection centres while 25 per cent said the produce was collected at their farm. The filed survey results are presented below.

Variable 12.   Whether french beans produce are collected at collection centres.

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Yes	1	88	73.3	73.3	73.3
No	2	32	26.7	26.7	100.0
		-------		-------	-------
	TOTAL	120		100.0	100.0

The field survey also wanted to establish the price of the french beans produce sold by the households. The households interviewed were therefore asked to state the average price of the french beans produce per kilogramme. The price ranged from three shillings to twelve shillings per kilogramme.

In the field survey, the respondents were required to state whether villages located near the feeder road studied received better prices for the french beans produce. From the field survey, 60 per cent of the respondents indicated that villages and farms located near the feeder road (studied) got better prices than those located far from the road. On the other hand, 33.3 per cent of the respondents indicated that proximity of household farms to feeder road did not affect the prices for the french beans, while 6.7 per cent of the respondents did not have any idea.

The frequency table below summarises these results.

Variable 14. Whether villages located near feeder road get better prices.

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Yes	1	72	60.0	60.0	60.0
No	2	40	33.3	33.3	93.3
Don't know	3	8	6.7	6.7	100.0
		-------	-------	-------	
	TOTAL	120	100.0	100.0	

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During the field survey the respondents were asked to state the most serious problem they thought affected the production of french beans. The results of the data on these variables are presented below in form of frequency table.

Variable 15. Problems facing small scale farmers on the production of horticultural crops

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Poor transport	1	60	50.0	50.0	50.0
Price fluctuation	2	17	14.2	14.2	64.2
Lack of input	3	12	10.0	10.0	74.2
Lack of market	4	15	12.5	12.5	86.7
Lack of organisation	5	10	8.3	8.3	100.0
Others	6	5.0	5.0	100.0	
TOTAL		120	100.0	100.0	

From the above table it is clear that 50% of the respondents showed inadequate transport as one of the main obstacles. Lack of adequate inputs was also indicated to be a major problem by 10 per cent of the respondents, while 14.2 per cent of the respondents cited price fluctuation as the major problem.

The farmers interviewed were also required to provide a rough estimate of their total proportion of land under horticultural crops. The results of the field survey on this variable are provided below in form of frequency tables.

Variable 17. Proportion of Horticultural land use

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
< 25%	1	49	40.8	40.8	40.8
25 %- 60 %	2	27	22.5	22.5	63.3
> 60 %	3	44	36.7	36.7	100.0
TOTAL		120	100.0	100.0	

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The above table shows that 40.8 percent of the respondents had less than 25 percent of their land under horticultural crops while 22.5 percent of the respondents had a range of between 25-60 % of their proportion of land under horticultural land use Over 36 percent of the respondents grew horticultural crops extensively with over 60 percent of their land under horticultural use.

4.3 Data Analysis II

Relationship between distance of household farms to the feeder road and farm gate prices of french beans.

4.3.1 Pearson's Product Moment Correlation Analysis

Correlation analysis was undertaken on the two variables of interest. The distance variable and the price variable were correlated. The results of the correlation analysis which was done using SPSS PC+ are provided below.

CORRELATIONS /VARIABLES V13.

Correlations: V13

V16   -.8708

From the above results we find that the correlation coefficient is -.8708

The correlation coefficient has the expected sign, that is, a negative sign, and it is one tailed significant at 99 per cent level of confidence. The negative sign of correlation coefficient indicates that as the distance between the farm and the main feeder road increases, the farm gate prices of french beans decreases. In short, an inverse relationship is implied.

This finding is consistent with similar studies of this nature conducted on the influence of

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distance variable between the farm and the market, on the one hand and the farm gate prices of agricultural commodities. Ahmed (1991) Guha (1984)

The coefficient of determination r^2 in this case was found to be 75.83 per cent. This can be interpreted as follows. That 75.83 per cent of the variation in farm gate prices of french beans can be associated with the variation in distance of the household from the main feeder road.

4.3.2 Bivariate Linear Regression Analysis

In order to establish the functional relationship between distance variable from the household farm to the feeder road and the price of french beans produce, simple linear regression analysis was conducted on the relevant variables.

In the data analysis simple linear regression was conducted to determine the influence of the feeder road on the farm gate prices. In this analysis, the main explanatory variable used was the distance between household farms to the feeder road.

The regression equation was of the form:

$$Y_i = \beta_0 + \beta_i X_i + e_i$$

Where Y_i = Farm gate prices of french beans

β_0 = Regression constant

β_i = Parameter estimate for the independent variable

e_i = Error term

X_i = Independent variable

The regression analysis was conducted using the SPSS statistical package. The following were the results.

Bivariate Regression Analysis

Equation Number 1   Dependent Variable..   V13   price

Variable(s) Entered on Step Number

1..   V16   distance

Multiple R   .87083

R Square   .75835

Adjusted R Square .75630

Standard Error   2.66478

The parameter estimates of the regression line yield the following equation.

$$Y_i = 16.244 - 0.87083 X_i + e_i$$

The above regression equation imply an inverse relationship which is understandable and consistent with the hypothesis of this study.

Interpretation of the Results

The parameter estimate of the independent variable has the correct sign. This

Shows the functional relationship between the variables of interest.

The coefficient of determination r^2 is 75.83 per cent. This figure indicates that of all the variations in the farm gate prices 75.83 per cent can be explained by variations in the distance variable between the household farm and the main feeder road. These results show that the distance between the household farm and the feeder road influence the farm gate prices significantly. These findings and results are consistent with similar findings

found in Ghana by Riverson and Hine (1979), where accessbility of households to the main road was found to be an important spatial variable affecting agricultural land use

The results of the simple regression analysis were further subjected to analysis of variance (ANOVA) to test their significance. The results were found to be significant at 99 percent level of confidence.

The analysis of variance table below shows these results.

Equation Number 1   Dependent Variable.. V13   price

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	2629.54555	2629.54555
Residual	118	837.92112	7.10103

$F =$ 370.30499   Signif $F =$ .0000

----------------- Variables in the Equation-----------------

Variable	B	SE B	Beta	T	Sig T
V16	-1.90565	.09903	-.87083	-19.243	.0000
(Constant)	16.24478	.45994		35.320	.0000

4.3.3 Hypothesis Testing

It will be recalled that one of the hypothesis formulated for the study was that household farm proximity to the feeder road influences the farm gate prices of the agricultural commodities (french beans).

From the primary data collected the validity of this hypothesis can now be tested using the results of the analysis of variance table at a certain level of significance

The ANOVA table above shows that the "F" computed is greater than the F value obtained from the ANOVA statistical tables. From these results we reject the null hypothesis on the basis of the data tested.

The null hypotheses tested were;

H_o There is no significant relationship between household proximity to feeder roads and the farm gate prices of agricultural commodities (french beans).

H_1 Alternative.

4.3.4 Multiple Regression.

In order to improve the regression equation, another independent variable was added to the previous simple regression equation already tested above. The quantity of french beans produce in kilograms produced by the households interviewed was included as an explanatory variable for the variation in farm gate prices of french beans produce in the study area.

The multiple regression model used was of the following nature.

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + e_i$$

Where Y_i = Farm gate prices of french beans

β_0 = Regression constant

β_1 = Parameter estimate for the first independent variable

β_2 = Parameter estimate for the second independent variable

X_i = Explanatory variables

e = Error term

The above regression equation implies a linear relationship which is understandable and in conformity with the hypothesis of the study.

The results of the multiple linear regression are as follows:

**** MULTIPLE REGRESSION ****

Equation Number 1   Dependent Variable.. V13 price

Variable(s) Entered on Step Number
1.. V9   quantity
2.. V16   distance

Multiple R   .87270
R Square   .76161
Adjusted R Square .75754
Standard Error   2.65801

Variables in the Equation

Variable	B	SE B	Beta	T	Sig T
V9	6.103608E-04	4.82314E-04	.05770	1.265	.2082
V16	-1.92355	.09979	-.87901	-19.277	.0000
(Constant)	15.89417	.53594		29.657	.0000

The parameter estimates of the regression line yield the following equation:

$$Y_i = 15.894 - 87901X_i + u_i$$

Interpretation of the Results

The coefficient of multiple determination r^2 is 0.76161 or 76.16 per cent. This shows that 76.16 per cent of the variation in farm gate prices can be explained by the variation in distance of the household farm from the feeder road and the quantity of french beans produced by the farmers.

By including one more explanatory variable the regression line fit has improved significantly. This shows that the quantity of the french beans produce also influence the farm gate prices from the supply side point of view.

The analysis of variance table for the above multiple linear regression is shown below.

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	2	2640.85980	1320.42990
Residual	117	826.60687	7.06502

$F =$ 186.89694   Signif $F =$ .0000

The above results shows that "F" computed is greater than the significant F' obtained from the statistical tables. On basis of these findings we reject the null hypothesis at 99 per cent confidence level.

4.3.5 Hypothesis Testing

H_0 There is no significant relationship between proximity of households farms to feeder roads and the farm gate prices of french beans.

H_1 Alternative.

The above null hypothesis is rejected at 99 per cent confidence level after conducting the "f" test or the analysis of variance.

By rejecting the null hypothesis above we confirm the earlier statistical tests obtained from the simple linear regression equation. Now. from the results of the multiple linear regression analysis, we conclude that the explanatory variables. namely distance between the household farm and the feeder road together with the quantity of french beans

...able are significant independent variables explaining the spatial variations in the farm

gate prices of the (agricultural commodity produce) french beans

4.4   Data Analysis III : The Influence of the Feeder Roads on Horticultural Land Use

4.4.1 Pearson's Product Moment Correlation Analysis.

Correlation analysis was undertaken on the data collected on the distance of the

households from the feeder road and the data collected on the size of the household land

under commercial horticultural farming.   The result of the correlation analysis between

these two relevant variables (i.e. variables 16 and 17 are shown below.

Correlation V16

V17   -.9463

The correlation coefficient was found to be 94.63 percent. The correlation coefficient for the

above two variables has a negative sign and is one tailed significant at 99 per cent level of

confidence. The negative sign of the correlation coefficient implies that the two variables

are inversely related to each other. This indicates that households' farm close to the feeder

road take more of their land to horticultural activities than those households located far from

the feeder road facility under investigation.

The coefficient of determination which is 89.5 per cent shows a relatively high

degree of association between the two variables. The sign of the correlation coefficient is

also consistent with the hypothesis of the study.

4.4.2 Simple Linear Regression.

The simple linear regression analysis was conducted to establish the functional relationship between the two variables, namely, distance and horticultural land use variables

The regression equation was of the form:

$$Y = \beta_0 + \beta_i X_i + X_2 + e_i$$

The regression equation estimated was of the following form:

Where Y_i = Horticultural land use in hectares

β_0 = Regression constant

β_i = Parameter estimate for the independent variable

e= error term

X_i = Independent variable

The results of the regression analysis using the data collected are as shown below

Bivariate Regression

Equation Number 1   Dependent Variable.. V17   horticultural land

Variable(s) Entered on Step Number
   1.. V16   distance

Multiple R	.94631
R Square	.89549
Adjusted R Square	.89461
Standard Error	.28667

Interpretation of the Results

The r^2 value of 0.89549 shows the coefficient of determination which is 89.54 per cent This value shows that 89.54 per cent of the variations in horticultural land use in the study area can be explained by the variation in distance of the households farm from the feeder road.

4.4.3 Hypothesis Testing

The null hypothesis tested was:

H_0 The proportion of the household land under horticultural use is not influenced by proximity to the main feeder road.

H_1 Alternative.

The significant tests for the above hypothesis were conducted using the "F" analysis of variance table. The table is provided below.

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	83.09445	83.09445
Residual	118	9.69721	.08218

F =   1011.13031   Signif F = .0000

---------------- Variables in the Equation ---------------

Variable	B	SE B	Beta	T	Sig T
V16	-.33876	.01065	-.94631	-31.798	.0000
(Constant)	3.29360	.04948		66.566	.0000

From the ANOVA table above it is evident that the "F" computed figure of 1011 13 is greater than the significant F table value at 99 per cent level of confidence.   Hence we

reject the null hypothesis on the basis of the statistical tests conducted using the available

data

4.4.4 Multiple Regression

In order to improve the fit of the regression equation, the size of land in hectares of the

households interviewed was also included as an explanatory variable together with the

distance between the household farm and the feeder road to explain the proportion of land

under horticultural use.

The multiple regression equation was of the following nature:

$Y_i = \beta_0 + \beta_i X_i + \beta_2 X_2 + e_i$

Where Y_i = Dependent variable

β_i and β_2 are Parameter estimates of the regression equation.

X_i = Independent variables

The results of conducting the regression analysis yielded the following results:

**** MULTIPLE REGRESSION ****

Equation Number 1   Dependent Variable..   V17   horticultural land

Variable(s) Entered on Step Number
1..   V16   distance
2..   V3   land size

Multiple   R = 0.94646
R square   R²= 0.89578
Adjusted R square R²=0.89400
Standard error   SE =0.28750

The coefficient of determination is 0.895 which is a relatively high figure. This means that about 89.57 per cent of the variation in the land (use) under horticultural farming is influenced by the distance of the farm from the main feeder road and the size of the total household land in hectares.

4.4.5 Hypothesis Testing.4.5 Hypothesis Testing

The hypothesis tested was:

H_o There is no significant relationship between accessibility of household farms to feeder roads and the proportion of land used for commercial horticultural farming

H_1 Alternative.

On basis of the ANOVA table tests provided below, we reject the null hypothesis given that F' computed is greater the significant "F" at 99 per cent level of confidence.

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	2	83.12093	41.56047
Residual	117	9.67073	.08266

F = 502.81346   Signif F = .0000

---------------- Variables in the Equation ----------------

Variable	B	SE B	Beta	T	Sig T
V16	-.33897	.01069	-.94691	-31.706	.0000
V3	8.379750E-03	.01481	.01690	.566	.5725
(Constant)	3.27801	.05675		57.758	.0000

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4.5 Spatial Variations of Agricultural Commodity Prices in Relation to Accessibility

The spatial variations of agricultural commodity prices within the study area was studied in detail in relation to accessibility. The data for this purpose was obtained from eleven retail markets spatially distributed within Thika District. This data was obtained from the district market office and the agricultural office. Nine agricultural commodities were studied and data on the respective prices were collected for three consecutive years.

The retail market centres studied were all located in urban centres and trading centres. These retail market include, Ndunyu-Chege, Kirwara, Gatura, Gatukuyu, Gatundu, Kiganjo, Kamwangi, Jamhuri, Ithanga, Mithi-ini and Ruiru. All of these markets were found to be located in areas that are well connected to the road network. However, varying degrees of accessibility are afforded to these markets.

In an effort to conduct a detailed analysis, the prices of selected agricultural commodities were collected for three years i.e. 1995-97. For this purpose the average prices were taken per the respective units of measurement. This information was obtained for all the eleven major retail markets in Thika District under study.

On the other hand, accessibility indexes were computed for all the retail markets using a standard coded schedule with points awarded according to various accessibility characteristics.

Accessibility indices were computed for the eleven retail markets based on the following factors.

i) Whether the market is located adjacent to a weather road or an all weather road and the passenger vehicles services operating locally at the market. The schedule used to compute the accessibility index is as follows.

Table 4.2: Standard Schedule used for Computing Accessibility Index of Retail Markets in the Study Area

A	Road Quality Characteristics	Score
	Located adjacent to an all weather road	4
	Situated at intersection of 2 all weather roads	5
	Situated at intersection of more than 2 all weather roads	
	Located adjacent to weather road	6
	Situated at intersection of 2 weather roads	1
	Situated at intersection of more than 2 weather roads	2
		3
B	Transport Service Characteristics	
	Passenger Bus Services Operating in the Market	
	20+	3
	10 - 19	2
	1 - 9	1

Source: Ministry of Lands and Settlement, Central Province Physical Development Plan (1973)

4.5.1 Data Analysis IV

The table below shows the average commodity prices for nine agricultural commodities sold at eleven major retail markets within Thika District for the period spanning three years from 1995-97. The prices are given in averages which is taken for a period of twelve months. The data was then compared to accessibility indexes of the respective retail markets in order to establish the relationship.

The accessibility indexes are also shown for the respective retail markets in the table below.

Table 4.3: Prices (Kshs. Per Kg) For Selected Agricultural Commodities in Major Retail Markets In Thika District.

Retail Markets	v1	v2	v3	v4	v5	v6	v7	v8	v9
Gatukuyu	12	31	11	3	13	30	23	83	5
Gatundu	12	31	10	2	10	27	22	80	7
Kiganjo	11	32	11	4	14	30	30	103	9
Kamwangi	11	31	12	3	10	22	22	88	3
Ndunyu Chege	12	31	11	3	11	25	22	87	3
Kirwara	12	30	11	2	12	26	23	83	6
Gatura	10	31	11	2	12	29	25	83	7
Jamhuri	17 .	34	12	6	14	23	28	90	9
Ithanga	12	28	12	3	7	25	17	76	3
Mithi-ini	12	29	12	4	9	28	15	83	2
Ruiru	12	34	12	5	14	29	27	100	9

In the above table 4.2 and table 4.3 below, variables V1 to V9 represent the following:

V1- Maize, V2- Beans, V3- Irish Potatoes, V4- Avocadoes.
V5- Sweet potatoes, V6- Peas, V7- Sorghum. V8- Green Bananas. V9- Accessibility Index.

Source: Computed by researcher from field survey data collected in 1997/98 and secondary data from Thika market office.

The most accessible retail market is the one that has the highest points awarded to it

on the basis of the criterion adopted above. From the table 4.2. Jamhuri market which

is located in Thika town is one of the most accessible market with an accessibility score

of nine points. Also Ruiru and Kiganjo market are relatively accessible given their

accessibility score of nine points.

4.5.2 Pearson's Product Moment Correlation Analysis

Correlation analysis was conducted between all the agricultural commodity prices in all the retail markets and the accessibility scores for all of these markets. The idea behind this analysis was to establish the relationship between accessibility of the markets and the commodity prices.

The table below shows the results of the correlation analysis based on the price data from the eleven market centres and the accessibility scores

Table 4.4: Correlation Analysis Results for Commodity Prices and Accessibility Index

	v1	v2	v3	v4	v5	v6	v7	v8	v9
v9	0.36	0.79	0.22	0.38	0.8	0.7	0.88	0.61	1

Source: Field survey data collected by Author and secondary data (1997/98)

The correlation analysis for all the commodity prices was compared with the accessibility index. The correlation coefficient computed ranged from 0.2158 to 0.8830. The correlation coefficient show a positive degree of association between the accessibility index and the retail prices for agricultural commodities. Out of all the 8 commodities prices investigated five had over 0.5 or 50 percent positive correlation coefficient with the accessibility index.

4.5.3 Simple Linear Regression

In an effort to establish and/or prove any causal relationship between the two variables of investigation namely, agricultural commodity prices in the retail markets, and accessibility index of the retail markets, simple linear regression analysis was performed. For this purpose, only one data set of retail prices was considered, namely the prices of green bananas.

The equation estimated was of the following form:

$$Y_i = \beta_0 + \beta_i X_i + X_2 + e_i$$

Where Y_i =   Price of green bananas

β_0 =   Constant

β_i =   Parameter estimate for the explanatory variable

X_i =   Explanatory variable, that is accessibility index.

Using the SPSS PC+ on the data set from the eleven retail markets the simple linear regression equation estimated yielded the following results.

$$Y = 76.2194 + 1.866\, X_i + e_i$$

Simple $r = 0.61314$
r square $r^2 = 0.375$
Adjusted r square $r^2 = 0.306$
Standard Error   SE = 6.81

Analysis of variance	D.F.	SS	MS
Regression	1	251.46	251.4628
Residual	9	417.44	46.382

Interpretation of The Results

The coefficient of determination r^2 is 0.375 or 37.5%. This shows 37.5 per cent of the total variations in the dependent variable i.e. The retail price of green bananas can be explained by the independent variable, namely the accessibility index

4.6   The Role of Feeder Roads in Agricultural Modernisation in Thika District.

This section addresses the issue of whether rural roads influence agricultural modernisation or not. Agricultural modernisation in this context refers to the application of new farming techniques and the introduction of new cash crops all of which are aimed at increasing production, diversifying and raising income base of the small scale farmers in the rural areas in the study area.

This section, therefore, examines the relationship between feeder roads and agricultural modernisation in the study area. The discussion that follows is based on secondary data as well as on physical observations made by the researcher during the field survey.

Rural roads in the study area influence agricultural modernisation through diffusion of innovation and ideas. These rural roads are the main channels through which information, people and commodities are propelled

In the study area, the introduction of new cash crops, especially high value cash crops is largely as a result of improved accessibility of the district to the city of Nairobi Among the recently introduced high value cash crops include a variety of Indian vegetables, such as green grams, spring onions, cow peas and avocadoes. For

example the dominance of avocadoes growing in Thika district intended for export market is largely due to its accessibility to the major markets especially Nairobi apart from climatic variables.

The avocado variety grown for export market was first introduced in Thika district late 1970s and by 1990 nearly all the small scale farmers in the district particularly in the middle agro-ecological zones were cultivating this crop (Thika District Development Plan 1997-2001). The fruits grown are intended for the export market.

The network of roads within Thika district has enabled agricultural extension workers to move deep in the rural areas to advise farmers on agricultural farming practices. Coupled with this, is the role that the feeder and access roads play in the delivery of agricultural input to the farmers. These include the delivery of chemical fertilisers, from cooperative union stores, animal feeds, and other agro-chemicals such as pesticides, herbicides among others.

Increased accessibility made possible by improvement in road access have also influenced the farming methods as seen in the previous sections. The rural roads have enabled farmers to shift from subsistence crop production to cash crop production. In Kakuzi, Ruiru and Thika divisions subsistence type of farming is still dominant among the farming community. This is due to various factors. These include inadequate road network and poor state of the roads. All this combined have led to inaccessibility of these areas to the urban markets. In view of this, despite the availability of irrigation water, horticultural export crops such as vegetables cannot be grown on a commercial basis in the lower zones of Thika District.

4.6.1 Data Analysis on the Influence of the Road Network on Agricultural Modernisation

In an effort to examine the role of roads in influencing agricultural modernisation, some parameters of the road network and agricultural modernisation were related to each other. Data was obtained from aggregate totals per division in Thika district. The data was collected on a number of variables, namely the percentage of land with high value crops, percentage of paved road network per division and the total surface area in square kilometres for the six administrative divisions in Thika district.

In order to study the relationship between roads and the high value crops, correlation analysis was conducted between the percentage of high value crops in each of the division and the road network, and the total surface area for each of the six regions. The table below shows the result of the correlation analysis done using SPSS PC+ computer package.

CORRELATIONS FOR VARIABLES V3 WITH V2

Correlations:	V2	V3
V2	1.00	.3666
V3	.3666	1.00

The correlation coefficient between the road network V2 and the percentage of the land under high value crops V3 was found to be 0.3666 percent. This means that 60.5 percent of the variation in the land under high value crops within Thika district can be

explained by variation in the road network. This results demonstrate the importance of road network in developing the rural areas through agricultural modernisation

4.7   The influence of the Roads on Utilized Agricultural Land in Thika District

Investigations were conducted to establish the relationship between road network and the road density per division on the one hand and the size of utilized agricultural land Data for this analysis was obtained from Thika District agricultural office and the public works office. The data collected was available in aggregate totals per the six administrative divisions of the district. Linear correlation analysis was performed for the classified road network and the size of land utilized for agricultural practices The results of the correlation analysis are shown below.

Correlation V2

V3   0.19

The correlation coefficient was 0.19. This shows that 43.6 percent of the variation in the utilized agricultural land can be positively with changes in the road network

Correlation analysis between road density and the size of utilized agricultural land per the six administrative division in Thika district was also undertaken. The results of the correlation analysis are shown below.

Correlation   V2

V1   0.336

The correlation coefficient between these variables was 0.336 This shows that 58.93 percent of changes in the size of the utilized agricultural land is associated with a change in the road density per square kilometre.

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4.7.1 The role of Rural Feeder Roads in Delivery of Agricultural Inputs to the Farming Community

As indicated earlier, agriculture is the dominant economic activity within Thika District. Most of the crops grown within Thika district require inputs which are available from the major urban centres in Kenya. These inputs include fertilizers, pesticides and other related farm inputs.

Coffee and tea farmers are the largest users of farm inputs especially fertilizers. The fertilisers are largely bought through cooperative societies. The delivery of the farm inputs to the coffee factories stores is undertaken by the cooperative societies using their own trucks. The farmers finally collect their fertilizer from their respective factories. Effective delivery of the fertilizers in the required time and place will therefore, require good rural transport in terms of good roads and the traffic to carry these inputs.

In areas where road transport is poor there has been delay in delivery of the farm inputs to the farmers. This is associated with decline in agricultural productivity given that (farm inputs) are required only in particular times of the year especially before the on set of the rain season.

The dairy industry and the poultry industry in Thika district equally rely heavily on the road transport. This is mainly due to the fact that animal and chicken feeds have to be transported through these roads before they finally reach to the farmers deep in the rural areas. It is worth noting that the majority of the animal feed

manufacturers are based in urban centres. In Thika district the farming community purchase the animal and chicken feeds from either wholesalers operating in Thika town or manufacturers based in Nairobi.

The existence of good road network is therefore of crucial importance in the growth and development of the rural based agricultural activities. In some villages within the study area, especially within the higher altitudes in Gatundu, Gatanga and Kamwangi, the delivery of farm inputs at the appropriate time is greatly hampered by impassable roads. This is a major bottleneck in increasing agricultural productivity in these areas, for without the necessary farm inputs agricultural production will stop or decline significantly.

Given the importance of agriculture in the face of a growing population it is therefore necessary to give priority to the improvement of the rural roads to make them all weather roads to ensure that they are in a position to indirectly promote and sustain the current levels of agricultural activities.

4.7.2 Land use Analysis in Thika District in Relation to the Road Network

The location quotient technique was used to analyze and describe the spatial distribution of land use in Thika district. The location quotient technique was used as it permit the use of numerical indicators which give a measure of the extent of concentration of particular types of land use in specific areas.

By definition, the location quotient shows the extent to which a given region specialises in a particular land use by comparing its share of the national area in that land use with its share of the regional area in all land uses.

In numerical terms the location quotient is thus computed:

Location quotient = $\dfrac{\text{Percentage of district land use in crop i in region j}}{\text{Percentage of division land use in all crops in region j}}$

The location quotient figures were then related to the road density to examine for any possible relationship between the road density and the concentration of the crops in each of the six regions.

The table below shows the three major land uses per administrative divisions in Thika District.

Table 4.5: Major Land uses in Hectares.

Division	Total crop area	Coffee/Ha	Banana/ Ha	Other Horticultural crops
Thika	555	218	145	192
Gatanga	5496	3511	800	1185
Kakuzi	975	524	273	178
Ruiru	727	300	255	172
Gatundu	6690	5068	687	935
Kamwangi	4558	2618	690	1250
Total	19001	12239	2850	3912

Source: District Agricultural Office, Thika 1997.

Table 4.5: Location Quotient (Derivation)

Div.	Coffee	Per-cent	Bananas	Per-cent	Other horticultural crops	Per-Cent	Total	Per-cent
Thika	218	1.78	145	5.08	1.92	4.9	555	2.92
Gatanga	3511	28.6	800	28.07	1185	30.29	5496	28.92
Kakuzi	524	4.28	273	9.57	178	4.5	975	5.13
Ruiru	300	2.45	255	8.94	172	4.3	727	3.82
Gatundu	5068	41.4	687	24.1	935	23.9	6690	35.2
Kamwangi	2618	21.39	690	24.2	1250	31.0	4558	23.98
Total	12239		2850		3912		1900	

Source: Computed from Thika District agricultural Annual reports by the author.

Table 4.6: Location Quotients for all the Three Types of Land Uses in Relation to Road Density

Division/Crop	Coffee	Bananas	Other Hort.Crops	Road density/Km^2
Thika	0.61	1.73	1.67	0.29
Gatanga	0.98	0.97	1.04	0.35
Kakuzi	0.83	1.86	0.87	1.01
Ruiru	0.64	2.34	1.12	0.62
Gatundu	1.17	0.68	0.67	0.87
Kamwangi	0.89	1.01	1.33	0.34

Source: Computed by author from Thika District Agricultural Annual Reports 1996/97

From the above table, the location quotients greater than one indicate those regions with more than their share of particular land uses. Location quotients for area under coffee production shows an even distribution of coffee production. Moreover, concentration of coffee production in Gatundu, Gatanga and Kakuzi is evident. The location quotients for these three division (areas) are 1.17 for Gatundu, 0.98 for Gatanga and 0.89 for Kamwangi. When these figures are compared with the road density per square kilometres, it is evident that these three divisions have a relatively better road network in terms of connectivity. Other factors that are responsible for the high values for location quotient for the coffee in these area include a favourable climate for coffee growing. Thika division has the lowest concentration of coffee production and apparently it has also the lowest length of classified road network.

Location Quotient for Horticultural Crops

The location quotient for other horticultural crops in all the major regions of Thika district indicate that four out of the six divisions have more than their share of these crops. These areas are: Thika, Gatanga, Ruiru and Kamwangi. The reason for these results could be attributed to the accessibility of these areas to major urban markets for the horticultural crops such as Nairobi and Thika. The lowest concentration of horticultural crops is in Kakuzi division. The reason for this lies largely in the climatic conditions of the region which falls within the marginal zone.

Location Quotient For Banana Crop

The location quotient for banana crop shows a high concentration of the crop in all the divisions in the district. However, it is only in four of the divisions where there is more than their expected share of this crop. It is worth noting that bananas are one of the major food and cash crop grown within Thika district. Gatanga and Gatundu division have less than their share of banana crop. This can be attributed to the availability of other high value cash crops which have occupied the place for bananas. The high value cash crops grown dominantly in these two areas include, pineapples, passion fruits, tea, cut-flowers and a variety of other cash crops.

4.8 The Impact of Poor Transport in Thika District

In areas where transportation is poor especially in Kakuzi, Ruiru and Thika division transport problems have severely limited agricultural production.

In Kakuzi division subsistence agriculture is dominant owing to among other things inadequate transport facilities. For instance, in these areas despite the climate being conducive to growing vegetables and other perishables for export the

farming community has not been able to grow these crops on a commercial basis owing to lack of access to markets.

In Thika district poor transport facilities have adversely affected the production of various agricultural commodities and animal products. Top on this list include tea, Coffee, milk and vegetables. For example, delivery of tea leaves to tea factories have been adversely affected due to impassable roads during wet seasons. In this way, tea delivery to factories is delayed for days and this affects the quality of the tea leaves which translates to reduced income to the farmers

In higher and middle zones where milk is produced for commercial purposes, the collection of the milk which is done by cooperative vans is greatly hindered during wet seasons due to impassable roads. In most cases milk from remote villages is not delivered to the market during wet seasons since the van collecting the milk cannot reach these villages. In such cases farmers are forced to travel long distances to deliver the milk while in the majority of cases, no milk is delivered. Hence, poor transport facilities have hindered the expansion of the milk business in the rural areas of Thika district.

The growth and development of the horticultural industry is the most hit in the study area due to lack of adequate transport facilities. Given that most of the horticultural products are perishable commodities, they require efficient transport This will enable these products to reach the desired markets in time. For example, cut flowers require to be delivered to their destination as soon as possible before going bad. Since most of the horticultural products are targeted for the export market, there is an urgent need to look into the problem of rural transport in Thika district.

Horticultural farming activity in Thika district is an important occupation for many people. It is therefore necessary to lay down strong transport infrastructural facilities to support this growing industry. As of now, there is a lot of loss of horticultural products emanating from rejects at the airport by the exporters, since most of these reach there when they have already gone bad. These contributes to the decline and dismal performance of the horticultural industry in the district in particular and in Kenya in general. This is evident from the field survey.

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CHAPTER FIVE

THE ROLE OF FEEDER ROADS IN PROMOTING RURAL

NON FARM ECONOMIC ACTIVITIES

5.0 INTRODUCTION

This chapter presents a detailed analysis and description of the interaction between feeder roads and rural non farm economic activities in Thika District. In order to do this more effectively the impacts and influences of the feeder roads on economic development in Thika district are examined by relating these feeder roads to certain growth indicators of rural development. This include the rural non farm economic activities.

Broadly stated, the purpose of this chapter is to examine to what extent households accessibility to roads and accessibility of rural market centres influences the growth and development of the rural sector. The data for this chapter was drawn from both primary and secondary sources.

5.1 RURAL DEVELOPMENT IN THIKA DISTRICT

Rural areas are distinguished from the urban areas by the nature and type of the dominant economic activities. The importance of the rural sector in Thika district stems from a number of factors. First, about 82 per cent of the population in Thika district live in the rural areas. Second, agriculture is the dominant economic activity and majority of the rural population are either self employed in

their own farms or employed in other large scale farms Third, and perhaps the most important is that it is in the rural sector that agricultural activities are based. The rural sector is therefore important in Thika district development. This means that development in the district cannot be realized fully without development of the rural sector.

The table below show the population distribution projections for Thika District major urban centres in 1997

Table 5.1: Thika District: Urban Population (1997)

Urban centre	No. of households	Total population
Thika	18,795	57,603
Ruiru	7,570	23,316
Total	26,365	80,919

Source: Thika District Statistics Office (1997)

Table 5.2: Thika District Population Projection by Division

Division	1997	1999	2001
Thika	96203	101948	108035
Ruiru	92785	98325	104196
Gatundu	127745	135372	143455
Kamwangi	110075	116648	123613
Gatanga	114633	121478	128731
Kakuzi	75617	80132	753833
Total	617058	653903	683413

Source: Thika District Statistics Office (1997)

As can be seen from the two tables above, the urban population in Thika district was approximately 13 percent of the total population in 1997, whereas, rural population will continue to be over 80 percent of the total population in the near feature.

These figures indicate that in Thika district rural development should continue to receive more attention in development matters and aspirations as that is where majority Of people live. However, in order to attain more balanced development it will be necessary to aim at achieving balanced rural and urban development. This will ensure that the urban sector will support the rural sector and vice versa.

Over the last seven years, there has been a general decline and

stagnation of the rural sector in Kenya owing to various factors. This has been mainly due to poor performance of the agricultural sector especially as a result of declining prices of major cash crops grown in the district, namely coffee and tea. These two cash crops have traditionally been the major cash crops of Thika district. It is also claimed that the decline of agricultural production in Thika district has been due to poor road network. In particular, the general condition of the feeder roads has deteriorated owing to lack of maintenance. For example, in higher altitudes, especially in Kamwangi, Gatundu, and Gatanga, tea delivery to factories has been hampered due to impassable roads, during wet seasons.

As a result, this has contributed to wastage of plucked tea leaves, and thus productivity has been reduced. Delays in transport has also caused reduction in quality and this translates to reduced income to the farmers. Milk delivery to cooling plants and collection centres has also been adversely affected by the poor condition and state of the roads. All of these have contributed towards stagnation and decline of the rural sector.

The growth and development of the rural sector in Thika district depends on the performance of the agricultural sector. In Thika district majority of the population derive their livelihood from the agricultural sector. Given this picture there is a need to focus on how these areas can be fully developed to provide among other things employment opportunities and adequate food to meet the needs of the growing population.

It is to be accepted that in Thika district the main economic activities are agricultural based. Thus if development has to occur in these areas it will have to start from the agricultural sector which is rural based.

In Thika district rural development has been influenced by various factors. These include climate, natural resource base and the human resources. Generally, the agriculturaly rich areas are well developed compared to the regions where agricultural activities perform poorly.

The administrative divisions which are relatively well developed compared to the others include, Gatanga, Gatundu and Kamwangi. In these areas the major cash crops namely, coffee, tea, and horticultural crops are grown on a wide scale. These cash crops are mostly directed towards the export market and have enabled most small scale farmers to earn substantial income. This has therefore contributed to a relatively good level of rural development in Thika district, compared to other districts in Kenya.

5.1.1 The Influence of Feeder Roads on Rural Development

The relationship between road transport and economic development is complex and indirect. However, empirical studies have come to a general consensus that infrastructure plays an important role in the development process,(Howe, 1984).

The purpose of this section is therefore to present the results of this study on several important aspects that were found to be directly or indirectly

influenced by the existence of the road facilities studied. The discussion that follows draws heavily on the primary data collected during the field survey.

In order to present the results of this study more systematically, we present in stages these findings, concerning the observed influences of the feeder road in the rural economy of the study area.

5.2 GENERAL EVALUATION OF THE INFLUENCE OF RURAL ROADS ON STIMULATION OF ECONOMIC ACTIVITIES

5.2.1 Introduction

In an attempt to study the influence and impacts of the rural roads on general economic activities a questionnaire was designed to collect the relevant data. The questionnaire was purposely designed to collect data on the influence of the roads on the location, growth and development of the non-farm economic activities and specifically the roadside business activities.

This questionnaire was administered by the researcher with the help of two research assistants. The questionnaire was administered to 108 respondents spatially distributed across the entire Thika district (study area).

The interview was conducted during a two month period ending January 1998. Specifically, the questionnaire targeted the owners of roadside business activities located along different rural roads within the district. These roads

reflected differences in surface quality and length.

At least 15 respondents were interviewed in all the 6 administrative divisions within the district. This was purposely done to ensure a spatially representative sample, more specifically the survey which was undertaken targeted owners of six different types of businesses located along the rural roads. These businesses were; vegetable vendor, Blacksmith, Tea kiosk, bicycle repair, general shop; and shoe repair.

The analysis and discussion which follow is based on the data collected from the questionnaire described above. This questionnaire is provided elsewhere in the appendces.

5.3 DATA ANALYSIS AND INTERPRETATION

Data was collected on a wide range of socio-economic variables relevant to this study. Among the variables on which data was collected include the sex of the respondent, type of business owned, type of road where the business was located, income earned from the business among many others.

Out of the 108 respondents interviewed 67.4 per cent of them were females and the rest comprising 30.6 percent were males. This result shows the dominance of women as the owners of the small roadside businesses along the rural roads of Thika District. The reason behind this lies in the fact that most of these businesses are temporary in nature and their income is too little to attract

men who would otherwise prefer regular engagement in other types of economic activities.

The frequency table below presents the result of the data obtained on sex characteristics of the respondents in the field survey.

Variable 2. Sex characteristic of the respondent

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Male	1	33	30.6	30.6	30.6
Female	2	75	69.4	69.4	100.0
		-----	-----	---	
TOTAL		108	100.0	100.0	

Source: Field survey Data Collected by the author in Thika District 1997/98

In the field survey those interviewed were also required to state their age in years. The frequency table below shows the range in which the respondents interviewed fall.

Variable 3. Age of the respondents

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
5-14 years	1	26	24.1	24.1	24.1
15-24 years	2	24	22.2	22.2	46.3
25- 34 years	3	51	47.2	47.2	93.5
35 + years	4	7	6.5	6.5	100.0
		---	----	---	
TOTAL		108	100.0	100.0	

172

From the above table we find that majority of the respondents interviewed forming 47.2 per cent fell in the age bracket (25-34 years). This is apparently the age bracket comprising the youthful and enterprising population. The table also shows that even children below 14 years are engaged in small scale business. Those over 35 years formed the minority group representing only 6.5 per cent of the total respondents.

Of the 108 respondents interviewed, they were all spatially well distributed within the six administrative division, namely Gatanga, Kakuzi, Kamwangi, Gatundu, Ruiru and Thika.On average 18 respondents were interviewed in each of the division. In Kamwangi only 17 respondents were interviewed while Gatundu had of 19 respondents who were interviewed. The total number of respondents to be interviewed was purposely determined to ensure a spatially representative sample covering the entire district.

During the interview the researcher also recorded the type of the business activity among the 6 listed business types. The table and the histogram shows distribution of these business types among the respondents.

Variable 5.   Type of Business

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Vegetable vendor	1	44	40.7	40.7	40.7
Blacksmith	2	16	14.8	14.8	55.6
Tea kiosk	3	23	21.3	21.3	76.9
Bicycle repair	4	4	3.7	3.7	80.6
General shop	5	11	10.2	10.2	90.7

173

V5   Type of Business

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Vegetable vendor	1	44	40 7	40 7	40 7
Blacksmith	2	16	14 8	14 8	55 6
Tea kiosk	3	23	21 3	21 3	76 9
Bicycle repair	4	4	3 7	3 7	80 6
General shop	5	11	10 2	10 2	90 7
Shoe repair	6	7	6 5	6 5	97 2
	7	3	2 8	2 8	100 0
		-------	-------	-------	
	TOTAL	108	100 0	100 0	

V5   Type of Business
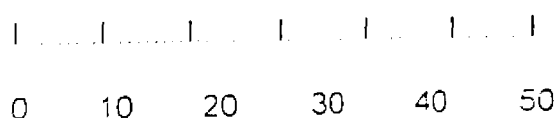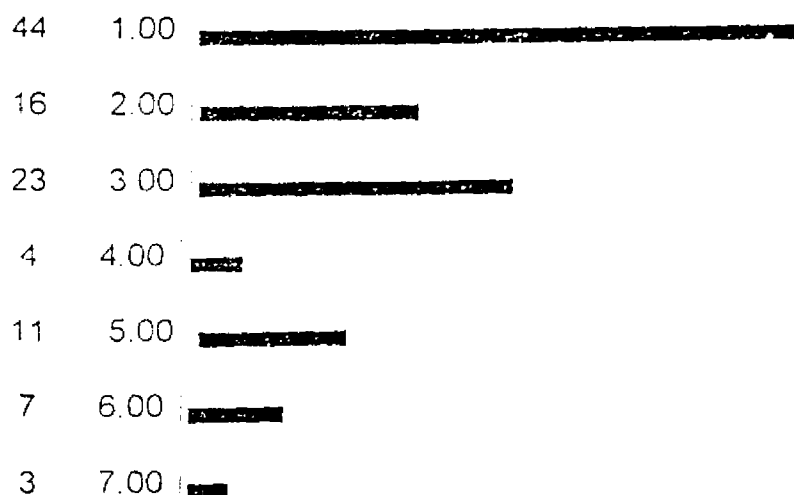
```
COUNT   VALUE

  44     1.00  ████████████████████████████████████
  16     2.00  ██████████████
  23     3.00  ████████████████████
   4     4.00  ████
  11     5.00  █████████
   7     6.00  ██████
   3     7.00  ██
               I....I....I....I....I....I....I
               0   10   20   30   40   50
                   Histogram Frequency

     Source    Computed by researcher from field survey data 1997/98
```

From the above table we find that vegetable vendor business had the highest number of people with 40 7 per cent of the total people interviewed. The second most important activity was Tea Kiosk business with 21 3 percent of the respondents. Shoe repair had the lowest number of people being engaged in the activity with only 2 8 per cent of the respondent interviewed.

The type of road near the roadside business studied were also recorded. Three types of road surfaces were identified as relevant. These were the loose surface dirt road. The loose surface muram/gravel road and the all weather road bound (Bitumen) surface

Most of the roadside business studied were located adjacent to loose surface roads. These comprised 59 of the road side business or 54 6 per cent of the total roadside business investigated. On the other hand those roadside business located along the loose surface dirt road comprised 20 4 per cent of the total roadside business studied. The rest of the roadside business were located along the all weather road bound surface and formed 25 percent of the total roadside business under the survey. The frequency table and histogram below summarizes the result of these finding.

V6   Road Surface

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Loose surface (dirt)	1	22	20 4	20 4	20 4
Loose surface murram	2	59	54 6	54 6	75 0
All weather road	3	27	25 0	25 0	100 0
		-------	-------	-------	
TOTAL		108	100 0	100 0	

```
COUNT   VALUE

 22     1 00 � bar
 59     2.00 ▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮
 27     3.00 ▮▮▮▮▮▮▮▮▮▮

        I. . . .I.  . .I.  . .I.  . .I.  . .I
        0    12    24    36    48    60
```

Histogram Frequency
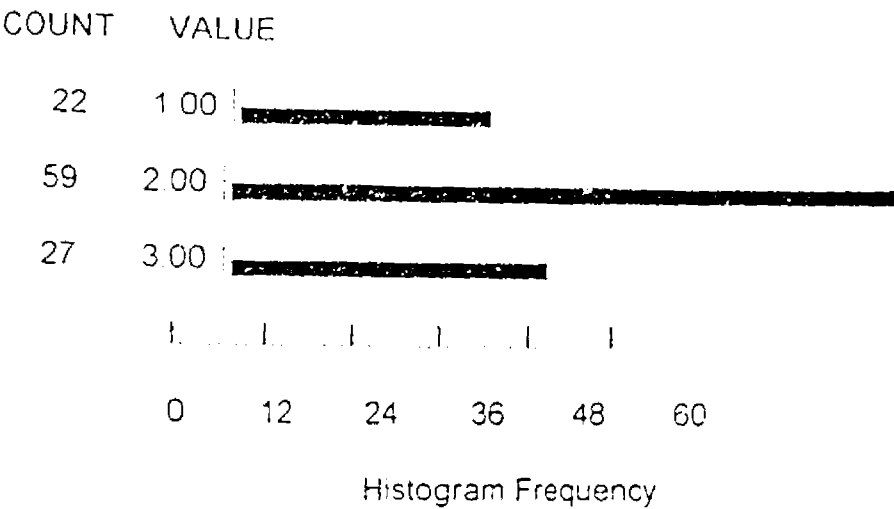
Source: Computed from field survey data collected by the author 1997/98

During the field survey the owners of the roadside business activities were required

to state whether the nature of the road surface influenced the location of their business

there. 47.2 per cent of the respondent indicated that the location of their business

near those roads was indirectly influenced by the type and nature of the road surface

and hence the accessibility afforded. 51 per cent of the respondent gave a negative

response while the rest choose other factors.

Another variable which was investigated during the field survey was whether the

owners of the roadside business, owned parcels of land fronting the road. The data

collected on this variable are provided below in form of frequency table and histogram

V8   Road Frontage

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Yes	1	74	68 5	68 5	68 5
No	2	34	31 5	31 5	100 0
		-------		-------	-------
	TOTAL	108	100 0	100 0	

```
COUNT    VALUE

  74      1.00 |████████████████████████████████████████
  34      2.00 |██████████████████
             I........I.........I.........I.......I......I
             0       15       30       45      60     75
```
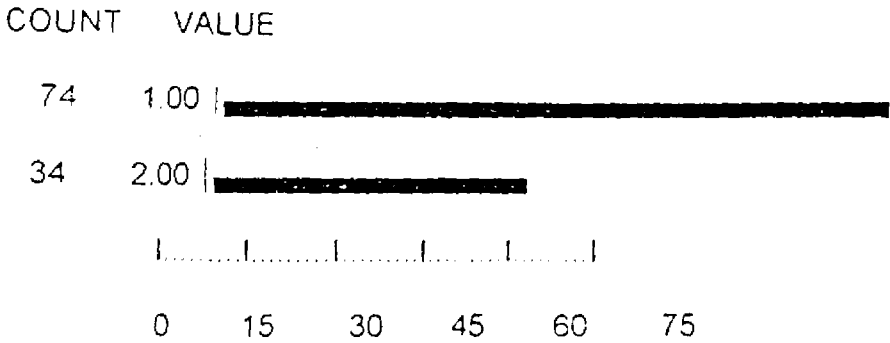
Histogram Frequency

Source: Field Survey Data 1997/98

Out of the 108 (respondents) roadside business owners interviewed 74 of them representing 68.5 per cent indicated that they owned parcels of land fronting the road, whereas the rest 34 respondents representing 31.5 per cent indicated that they did not own any piece of land fronting the road.

From these results it can be seen that those people owning parcels of land with a road frontage have a higher probability of opening up roadside business near the roads This can be attributed to the relative ease of accessibility afforded to these people

compared to those people who do not own parcels of land fronting the road. The results further shows that there is a high chance of people near the roads engaging themselves in non-farm economic activities along the roads in form of small roadside business and crafts. The importance of roadside business economic activities in rural development is straight forward and need no further elaboration here. The non-farm economic activities do provide employment opportunities to the rural population. They are instrumental in reducing the pressure in agriculture resulting from the growing population in the rural areas.

In the survey of the roadside business activities the owners of these business were asked to state the annual income obtained from these business during a month. The result of the field survey are summarized below in form of a frequency table and histogram. Other measures of central tendency are also computed.

V9   Business Income

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
0- 4000 ksh	1	51	47 2	47 2	47 2
5000- 9000 ksh	2	38	35 2	35 2	82 4
10000+	3	19	17 6	17 6	100 0
	TOTAL	108	100 0	100 0	

```
COUNT    VALUE

  51     1 00 ▐████████████████████████████████████████
  38     2 00 ▐█████████████████████████████████
  19     3 00 ▐████████████
              |.........|.........|.........|.........|.....|
              0     12    24    36    48    60
```

Histogram Frequency
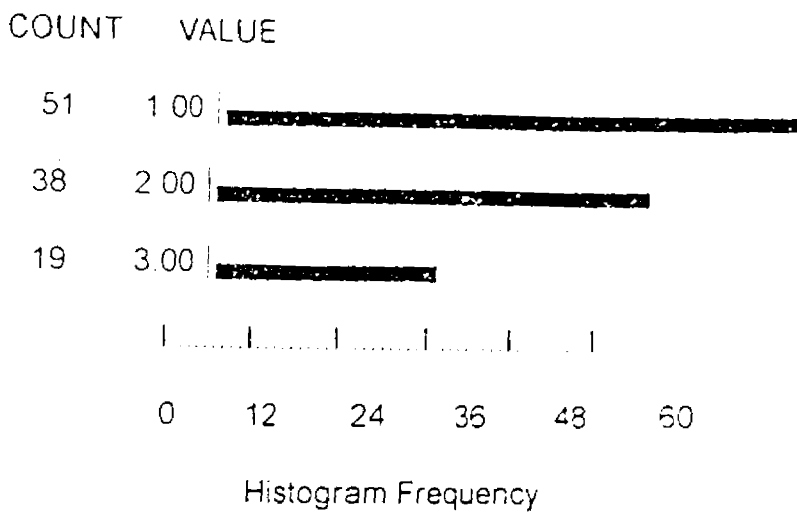
From the above table 47.2 per cent of the respondents indicated that the income from their roadside business was below Kshs.4000 per month Similarly, 35.2 per cent of the respondents indicated that their business income ranged from 5,000 - 9,000. Finally, 17.6 per cent indicated that their business income per month was over 10,000 shillings.

From the above results, it can be argued that most of the small roadside business located along the rural roads are just meant to supplement income from other activities The income levels of these roadside business activities also indicate that they are small in nature with small capital This shows that many people can enter into these activities with ease This would assist in generating employment opportunities to the rural population

The owners of the roadside business activities were also asked to state the number of people engaged as workers in the roadside business activity. The frequency table and histogram below provide a summary of the results from the field survey.

V10   No of Business Employees

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
1- 2	1	60	55.6	55.6	55.6
3-5	2	36	33.3	33.3	88.9
6 +	3	12	11.1	11.1	100.0
		-------	-------	-------	
TOTAL		108	100.0	100.0	

```
COUNT    VALUE

  60     1.00 |████████████████████████████████████
  36     2.00 |████████████████████████
  12     3.00 |██████████
             |....|....|....|....|....|....|
             0    12   24   36   48   60
```

Histogram Frequency

Source: Field Survey Data collected by the author.

180
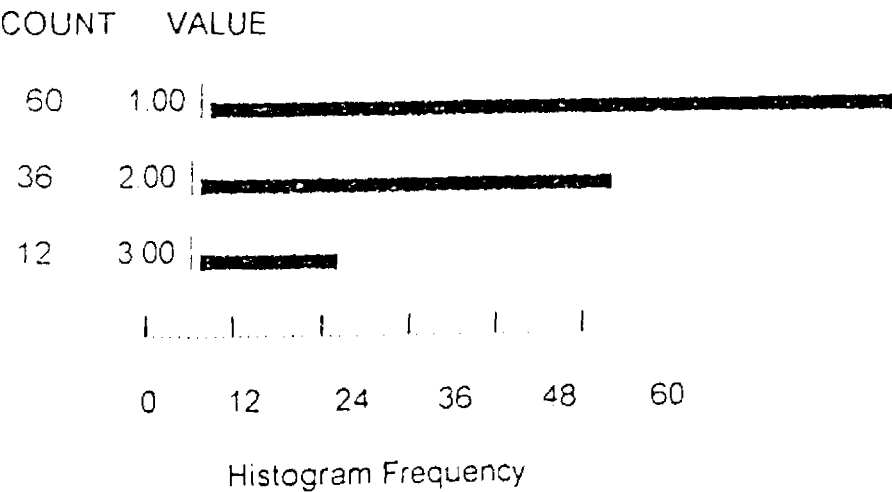
The table shows that 55 6 percent of the roadside business engaged between one and two people as workers This is usually the owner of the roadside business However 33.3 percent of the business engaged between 3-5 workers in the business In this category belong most of the tea kiosks studied Those roadside business employing more than 6 people comprised only 11.1 percent of the total roadside business studied.

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From the data provided above it can be seen that the importance of the rural roadside non-farm economic activities in terms of providing employment opportunities Apart from providing employment opportunities the roadside business activities do also provide a market for the goods produced in the rural areas

The roadside business activities studied were also categorized as permanent or temporary on the basis of the physical structure of the business premise The table below shows the result of the field survey.

V11   Type of Business Premise

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Permanent	1	45	41.7	41.7	41 7
Temporary	2	63	58.3	58.3	100 0
		-------	-------	-------	
	TOTAL	108	100 0	100 0	

```
COUNT   VALUE

 45     1 00
 63     2.00

        |......|.   |.....|...|.   |     |
        0    15    30    45    60    75
```

Histogram Frequency

Out of the 108 roadside business studied only 41.7 percent of the respondents

indicated that their business was located on a permanent business premise structure

The rest comprising 58.3 percent indicated that their business was carried out in a

temporary business premise. The data collected shows that most of the roadside

business activities were temporary in nature such that they could stop operating

anytime given that most of then did not have any permanent premise It is worth

noting that in fact, majority of the business activities. even in the major trading centres

in rural areas are housed in temporary buildings   Thus. the field survey findings are

consistent with the nature of business activities in the rural areas

The owners of the roadside business activities were also asked to state reasons fo

locating these business along the rural roads. Four possible answers were provide

in the   closed questionnaire. The result of the field survey on this variable ar

provided below in form of a frequency table and a histogram

V12   Reason for Location of Business near the road

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Personal preferences	1	15	13.9	13.9	13.9
Accessibility	2	67	62.0	62.0	75.9
Ease of transport	3	16	14.8	14.8	90.7
Own land fronting road	4	10	9.3	9.3	100.0
		-------	-------	-------	
	TOTAL	108	100.0	100.0	

V12   Reason for Location of business near the road

COUNT   VALUE

```
 15    1.00  |████████
 67    2.00  |████████████████████████████████████
 16    3.00  |████████
 10    4.00  |███████
             |.....|.....|.....|.....|.....|
             0    15    30    45    60    75
                 Histogram Frequency
```
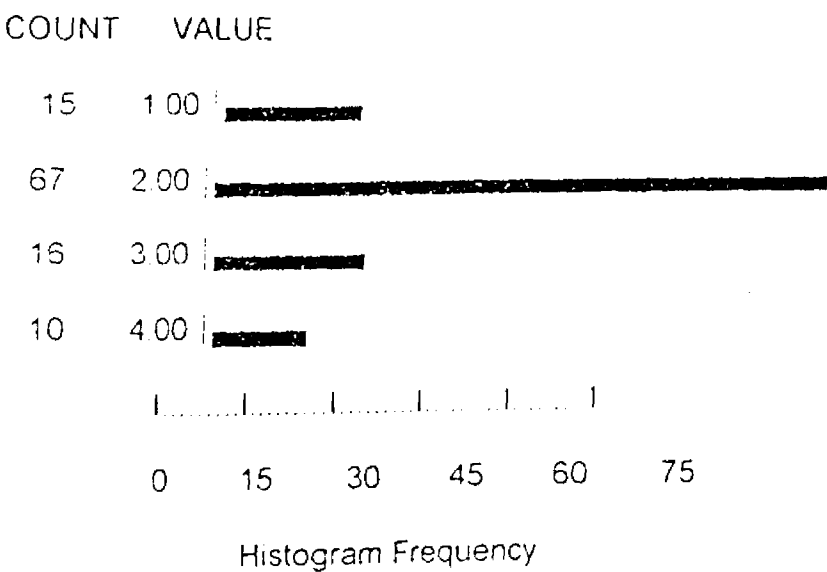
Source: Field Survey Data

Out of the 108 respondents interviewed the majority comprising 62 percent indicated that accessibility to customers was the major reason for locating the business along the roads. 16 percent of the respondents indicated the ease of transport services afforded near the roads as an important factor in their locations decisions. The other 15 percent of the respondents indicated that personal preference was the major reason for locating their business there, while 10 percent of the respondents indicated that they owned land fronting to the road.

The field survey also sought to examine the number of passenger vehicles operating regularly on the roads in which the roadside business were located or otherwise. 54.6 percent of those interviewed indicated that the passenger vehicle services operated regularly while 44.4 percent indicated irregular passenger bus services along those roads.

The table below shows the result of these findings

V13   Passenger Vehicle Services operating along the road where road side business are located

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Yes	1	59	54.6	54.6	54.6
No	2	48	44.4	44.4	99.1
	4	1	.9	.9	100.0
		-------	-------	-------	
	TOTAL	108	100.0	100.0	

```
COUNT    VALUE

 59      1 00 |████████████████████████████████████

 48      2 00 |██████████████████████████████

  0      3 00 |

  1      4 00 |▪

              |.....|........|....|........|.....|...|
              0    12    24    36    48    60
```
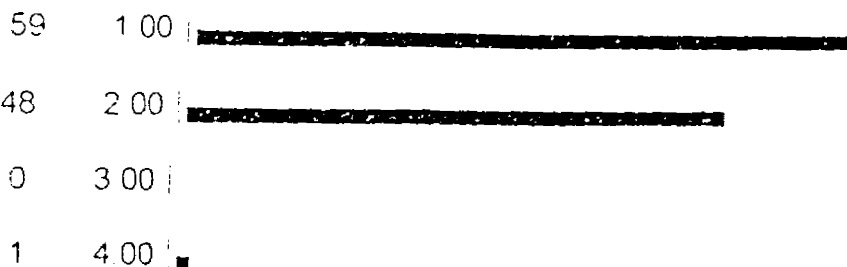
Histogram Frequency

The mode of transport used by customers to reach the roadside business was indicated to be walking by 89.3 percent of those interviewed. Whereas only 10 2 percent of the respondents used vehicles to reach the roadside business These result shows that roadside business draw their customers from the local area, particularly those residing near the roadside business and occasionally the passengers travelling and alighting from the passenger vehicles operating along these roads.

The table below shows the result of this finding

V14   Transport mode used to reach the business premise

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Vehicles Motorised	1	11	10.2	10.2	10.2
Walking	2	97	89.8	89.8	100.0
		-------	-------	-------	
TOTAL		108	100.0	100.0	

COUNT   VALUE

```
11    1.00 |████
97    2.00 |███████████████████████████████
      |......|......|......|......|......|
      0    20    40    60    80    100
```

Histogram Frequency
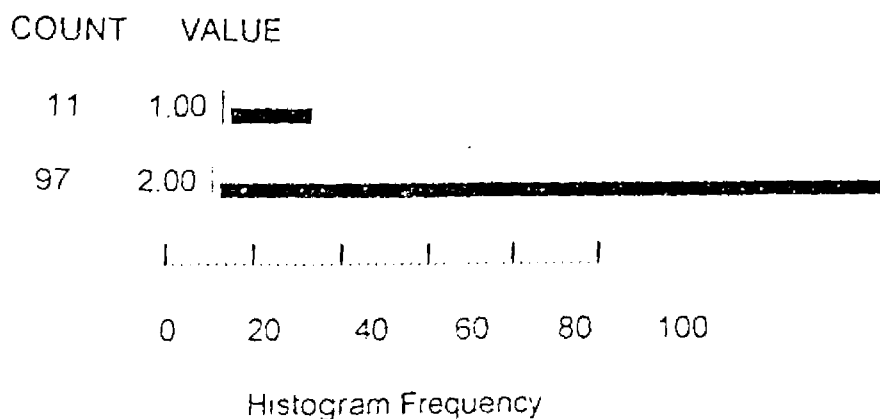
From the table below it is apparent that 76.9 percent of the respondents indicated that customers for the roadside business were drawn from the local area. The rest forming 23.1 percent of the respondents indicated that the customers for the road side businesses were drawn from other areas.

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Local area	1	83	76 9	76 9	76 9
Other areas	2	25	23 1	23 1	100 0
		-------	-------	-------	
	TOTAL	108	100 0	100 0	

```
COUNT    VALUE

  83      1.00 |████████████████████████████████
  25      2.00 |█████████████
               |.......|.......|.......|.......|.......|
               0      20      40      60      80     100
               Histogram Frequency
```
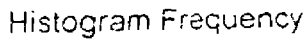
The reason behind the customers for the roadside business activities being drawn from the local area rests on the fact that, most of the roadside business are small in nature and they particularly deal with goods demanded within the (local) area of influence.

5.4 The Impacts of The Rural Roads on the Growth and Development of Non-Farm Economic Activities

From the field survey undertaken by the author there is strong evidence to suggest that roads have an important role to play in the growth and development of roadside economic activities.

By opening up rural areas, the development of road network has the capacity to encourage the growth of roadside business activities. These activities as seen before, are instrumental in rural development. For instance, in areas with high population pressure and dependent on agricultural activities, such as the study area, the growth and development of non-farm economic activities are seen as an important element in easing pressure in the agricultural sector. This pressure is reflected in form of land subdivision and fragmentation whereby the law of diminishing returns sets in. In this condition, increased inputs in the land, the main factor of production, is accompanied by decreased returns in output. In such a situation, alternative sources of income such as those provided by roadside business activities are crucial in reducing the

pressure in agricultural land and even reducing poverty levels in the rural areas

It is also claimed that in order to attain desired levels of rural development there is a need to improve the rural infrastructural facilities including the road network. That roads improvement can have an impact on rural development has been established through the field survey. It was seen that increased and enhanced mobility is directly associated with increased levels of income. In order to promote rural development it may be necessary to improve the rural road transport networks. This will reduce the costs of transport of the outputs and inputs in the rural sector.

The result of the field survey also shows that if accessibility of the rural sector is improved, there is likely to be accompanied increases in the level of income generated. This stems from the fact that improved accessibility will be associated with increased movement of goods in and out of the rural sector, such as agricultural inputs and outputs.

The field survey results also indicate that there is a direct relationship between accessibility and the prevalence of non-farm economic activities, along the rural roads. This is an important result in rural development planning.

5.5 ROAD TRANSPORT AND DEVELOPMENT OF RURAL MARKETS CENTRES.

The growth and development of rural market centres are indirectly influenced and determined by the availability of transport infrastructure. It should be noted that most of the rural markets in the study area are periodic in nature being held once a week or twice a week. The major retail markets in Thika district include, Ruiru, Gatukuyu, Ndunyu-Chege, Kirwara, Kaguku, Kakuzi and Ithanga. All of these markets are located along the major roads within Thika district. In an effort to study the influences of the rural roads on development, growth and the size of non farm economic activities, market centres, accessibility indices were computed for a selected number of rural market centres located along the principal roads. The main types of roads used to compute the connectivity and accessibility indices were international trunk roads, primary roads and secondary roads.

Ten trading and market centres located along these principal roads were studied and their connectivity and accessibility indices were computed. The Network Analysis Technique was applied in computing the connectivity and accessibility indices of the nodes.

The ten market centres studied include Ruiru, Thika, Kiganjo, Gatundu, Gatura, Ithanga, Makutano, Gatuanyaya, Gatukuyu and Kalimoni. The data for this purpose was obtained from secondary sources especially from published materials obtained from Thika district Government offices. The accessibility indices computed were then compared to the size and structure of non farm

economic activities. Standard schedules were used to compute the accessibility and connectivity characteristics of the rural market centres studied. In order to compute accessibility indices for the market centres under study a topological diagram was drawn from the road network map of Thika district. This topological diagram shows a linkage of all the market centres under study with the road network. The topological diagram used to compute the accessibility indices is provided below.
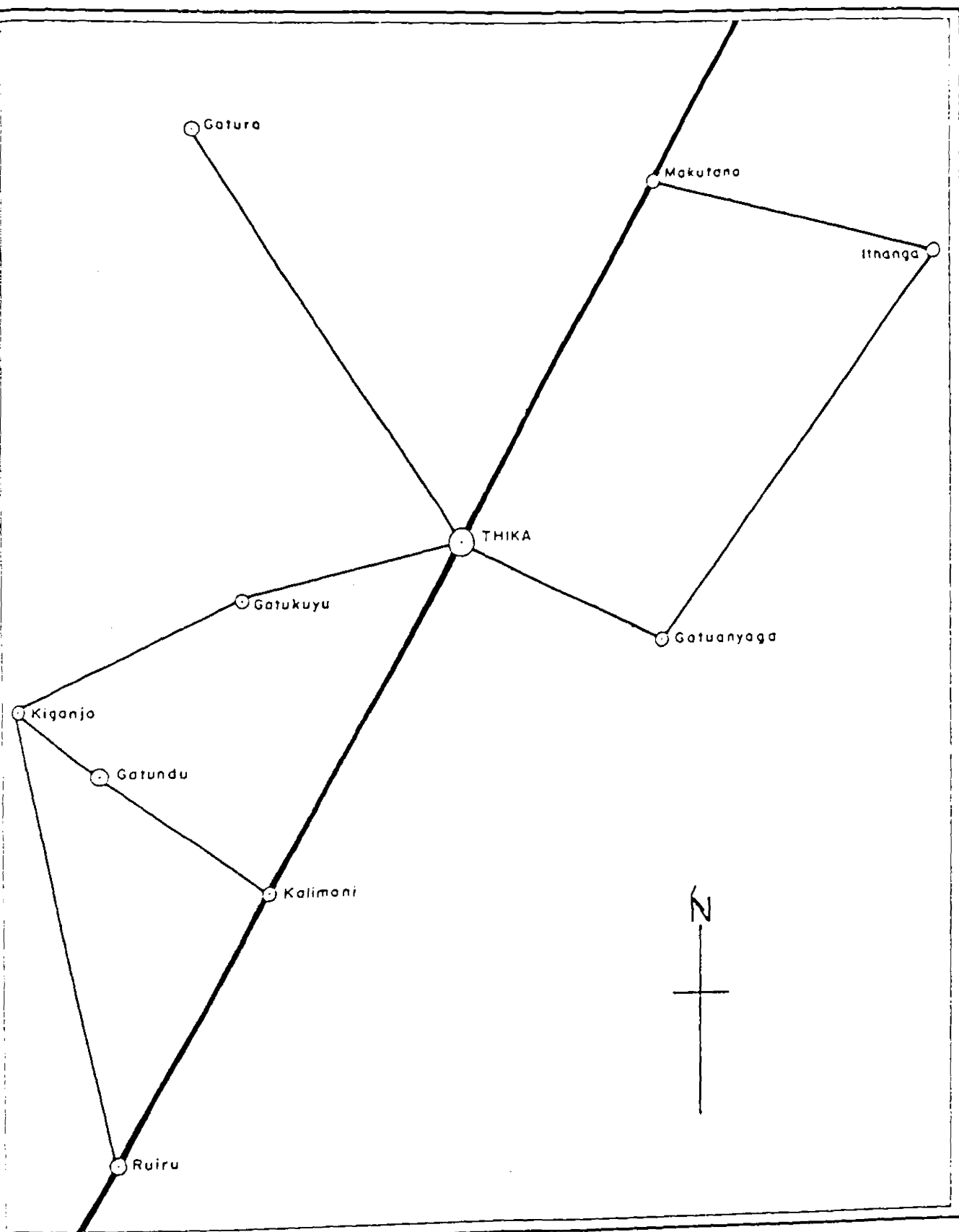
Figure 5.1   Topological diagram of Road Network in Thika District linking
principal trading centres.

From figure 5.1, using the shortest path analysis, a connectivity matrix was developed showing all the market centres. In this case accessibility between each pair of centres/nodes in the system was expressed in terms of the number of edges along the shortest path connecting them. This connectivity matrix pertaining to the above diagram is shown below.

TABLE 5.3: Connectivity Matrix Pertaining to fig 5.1

Market Centres	Ruiru	Kalimoni	Gatundu	Kiganjo	Gatukuyu	Thika	Gatura	Makutano	Gatuanyaga	Ithanga	Associated Number
Ruiru	-	1	2	1	3	2	3	3	3	4	4
Kalimoni	1	-	1	2	2	1	2	2	2	3	2
Gatundu	2	1	-	1	1	2	3	3	3	4	4
Kiganjo	1	2	1	-	2	3	4	4	4	5	5
Gatukuyu	3	2	1	2	-	1	2	2	2	3	3
Thika	2	1	2	3	1	-	1	1	1	2	3
Gatura	3	2	3	4	2	1	-	2	2	3	4
Makutano	3	2	3	4	2	1	2	-	3	1	4
Gatuanyaga	3	2	3	4	2	1	2	3	-	1	4
Ithanga	4	3	4	5	3	2	3	1	1	-	5
Total	22	16	20	26	18	14	24	21	21	20	38

5.5.1 Data Analysis and Interpretation

Accessibility measures were computed and shimbel index number was used for representing the accessibility indices. The summation of either row or column totals in the above matrix indicates the most and least accessible nodes. Using the figures derived for Thika district the following results come out clearly. From the connectivity matrix, Thika town represents the point of greatest accessibility within the system. This is therefore the central node of the network. Ithanga and Kiganjo trading centres are the least accessible with respect to all other points in the system of road network. In the accessibility and connectivity matrix, the associated number for each node is the highest of the shortest path link connecting that node to all others. For example. The associated number for Thika town is 3. The lower the associated number, the greater the relative accessibility of that place.

Kalimoni trading centre, which is located along Ruiru-Thika road has a shimbel number of 16 and is relatively accessible within the system. The reason behind this is the fact that this market centre is located along Thika -Nairobi highway. Gatukuyu market with shimbel number of 18 is also among the relatively accessible points within the system.

Connectivity Matrix

More realistic measures of accessibility were derived using actual distances between places, presenting the figures in

Table 5.4:   Distance (km) Matrix to Determine Which Market Centre has the Greatest Accessibility

Market Centre	Ruiru	Kalimoni	Gatundu	Kiganjo	Gatukuyu	Thika	Gatura	Makutano	Gatuanyaga	Ithanga
Ruiru	-	8	14.5	30.5	35	19	48	30.5	45	48
Kalimoni	8	-	20.5	25	31	12	42.5	25	33.5	40
Gatundu	4.5	20.5	-	7	8.5	21.5	51.5	34	44	50.5
Kiganjo	30.5	25	7	-	15	25	60	40	52	43
Gatukuyu	35	31	8.5	15	-	14.5	45	30	37	43
Thika	19	12	21.5	25	14.5	-	45	14.5	22.5	30
Gatura	48	42.5	51.5	60	45	30.5	-	59.5	67.5	74
Makutano	30.5	25.5	34	40	29	14.5	45	-	37	40
Gatuanyaga	45	34	44	52	37	22.5	67.5	37	-	11.5
Ithanga	48	41.5	50.5	59.5	43	30	74	43	51.5	-
Total	278	239.5	251.5	326	258	189.5	478	313.5	389.5	379.5

Source: Field survey data and secondary data collected by the author in Thika District 1997/98.

matrix form and summing row or column totals. These figures were obtained from the connectivity matrix table provided below.

Interpretation on Connectivity Indices:

From the connectivity indices computed above there is evidence to suggest that the least accessible points in the system are peripheral points of Ithanga, Gatura and Gatuanyaga. The most accessible points are Ruiru, Thika, Gatundu, Kalimoni and Kiganjo.

In order to fully analyze the influence of accessibility of these rural trading and market centres on the size and structure of non farm economic activities, accessibility indices were computed. A comparison was made on the non-farm sector in these centres and the accessibility index.

Table 5.5 Ranking of Accessibility Index from the most Accessible to least Accessible

TRADING CENTRE	ACCESSIBILITY INDEX	MOST ACCESSIBLE TO LEAST
Ruiru	22	10
Kalimoni	16	9
Gatundu	20	8
Kiganjo	26	7
Gatukuyu	18	6
Thika	14	5
Gatura	24	4
Makutano	21	3
Gatuanyaga	21	2
Ithanga	26	1

Source: Computed from field survey data collected by the author 1997/98.

From table 5.6 relating accessibility to the size and structure of selected non farm economic activities above, we find that Ruiru, Thika, Gatundu, and Kiganjo have a relatively well established number of those non farm economic activities listed. It is also important to note that these market centres have a relatively high level of accessibility as can be seen from the rank of accessibility index. It can therefore be concluded, on basis of the above observations that there is a high positive correlation between accessibility of trading and market centres with the size and structure of non-farm economic activities.

Table 5.6   Relationship Between Accessibility and the Size and structure of Non Farm Economic Activities.

Market	Accessibility Rank	Size and structure of non farm economic activities						Market No of days/wk
		MANUFACTURING			SERVICE & TERTIARY			
		Agro-Based Industries	Non-Agro based Industries	Jua Kali	Bank	Insurance	Post Office	
Ruiru	4	y	y	y	y	y	y	7
Kalimoni	9	y	n	y	y	n	n	2
Gatundu	7	y	n	y	y	y	y	2
Kiganjo	2	y	n	y	n	n	y	2
Gatukuyu	8	y	n	y	n	n	n	1
Thika	10	y	y	y	y	y	y	7
Gatura	3	y	n	y	n	n	n	2
Makutano	6	y	n	y	n	n	n	1
Gatuanyaga	5	y	n	y	n	n	n	1
Ithanga	1	y	n	y	n	n	n	1

N.B y means presence of the economic activity in the market centres.
n means absence of the economic activity in the market centres.

Source: Computed from field Survey and secondary data collected by the author in Thika District.

implies that the more accessible a trading centre is, the greater the size of non farm economic activities and the more diversified they will be. This is an important finding for purposes of rural development planning.

5.6 FEEDER ROADS AND POVERTY ALLEVIATION IN THIKA DISTRICT

The purpose of this section is to describe and analyze the direct and indirect influences of the feeder roads on poverty levels in the rural areas. The idea that roads influence income levels of the farming community is the premise upon which the discussion that follows is based.

Do roads influence income levels in the rural economy and hence poverty levels in the study area.? From the field survey data collected it was found that farm gate prices of agricultural commodities can vary from farm to farm depending on the location of the farm. That accessibility of household farms can and do influence the farm gate prices of agricultural commodities has already been established in the previous chapter.

Extending the above analysis further, it can be seen that the income for the farming community is a function of, among other things prices of the produce. If we assume that the output of the farmer is constant, then when the price of the agricultural commodity improves, the income earned will also increase. In this way it can be rightly argued that accessibility to roads and even rural markets affect the levels of income of farmers. Hence, the provision of

improved roads to all the farmers in all villages will thus indirectly affect the levels of income and positively reduce the rising levels of poverty in the rural areas of our country.

Rural road provision and improvement will also affect the levels of employment indirectly. The improvements of roads is followed by an increase in the growth and development of roadside economic activities, all of which serve mostly the local communities. These economic activities are run and managed by people who would otherwise be unemployed. Furthermore, road construction provide employment opportunities to the local population. This then translates into multiplier effect in the rural economy, whereby the demand for goods and services provided within the rural areas rises thereby raising the level of economic activities. For example, the World Bank funded roads projects in Kenya particularly the rural access roads and the minor roads programme all of which are going on in Thika district have created employment opportunities to the local people. The constructions of these roads emphasize on labour intensive technologies. By providing employment opportunities to the local population these road projects have enabled these people to earn a wage income. This income is finally spent mostly in the rural economy. In this way it can be shown that roads do have a positive impact on employment creation and generation.

Roads provision also affect the level of poverty in the rural areas through

migrations. With the flow of information and ideas, unemployed people in the rural areas can move easily with increased mobility that is afforded by the improvement of the roads. There is strong evidence to suggest that accessibility of rural areas is correlated to outward migration. That is, in areas with high levels of accessibility, such as in Thika, Ruiru and Gatundu division, people move more efficiently in less time to perform other income generating activities, especially in the urban centres. In this way it is easier to move to the regions where the potential for making money and profits are higher, hence enhanced mobility will indirectly affect the levels of poverty in the rural areas of Thika district.

5.7 RURAL ROAD TRANSPORT IN RELATION TO THE GROWTH AND DEVELOPMENT OF CENTRAL PLACES IN THIKA DISTRICT

Rural road transport networks do have the capacity to encourage nucleation and development of central places along the networks especially at cross roads.

An investigation of central places in Thika district was attempted and studied in detail. The location of these central places was related to the road facility. The data for this purpose was obtained from Thika County Council.

The table 5.7 below summarizes the data for the 106 central places and their location in relation to the road facilities.

Table 5.7 Location of Central Places in Thika District Relation to the

Road Facilities

Division	Located adjacent to a motorable road		Located at crossroads of a motorable road	
Division	Central Places	Percentage		
Kamwangi	25	25.6	10	25.6
Gatundu	33	28.2	11	28.2
Gatanga	24	30.7	12	30.7
Ruiru	9	5.4	2	5.4
Thika	7	2.5	1	2.5
Kakuzi	8	7.6	3	7.6
Total	.106	100	39	100

Percentage located adjacent/near motorable road 100 %

Percentage located at crossroads of motorable road 36.79 %

Source: Compiled from Field survey data (1997/98) and secondary data by the author.

From the table above it is apparent that central places have a clear preference for road sites. We also note that most of the central places are located at cross roads.

For example the road linking Ndaka-ini shopping centre to the main Thika-Gatura all weather road used to be a weather road before the construction of Nairobi city council's Ndaka-ini dam. However, the road was improved to an all weather standard to ease the transport of raw materials and people during

the construction of the dam. Immediately after this road was improved, there was an upsurge in the number of passenger vehicles operating along this route. Furthermore, the centre started expanding and new shops were constructed. Although the impact of migrant workers on the economic activities of the centre were clear, the road improvement was also a major factor for the increase in the level of economic activity in the centre and along the road especially roadside business activities. Construction of new shops at the Ndaka-ini trading centre has also been taking place, as a result of the improved accessibility. High class hotels and shops were also opened recently after the improvement of the road. This example show the direct influences and impacts which road improvement can have on the rural economy.
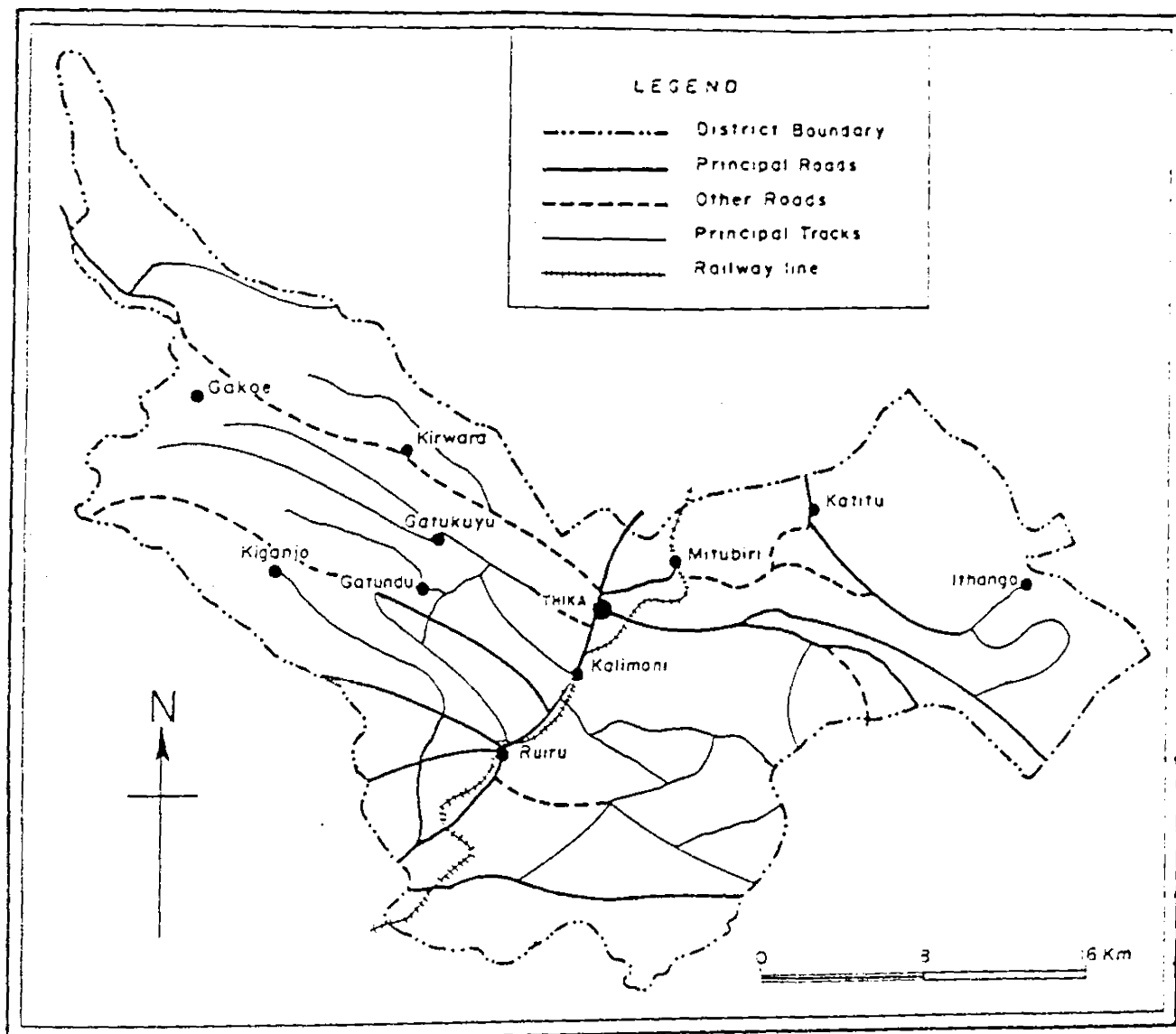
Figure 5.2 Thika District Road Network, 1959
Source: Reconstructed from Kenya Atlas, Survey of Kenya, 1959

Table 5.8: Suggested Relationship of Roads of Different Types to the Rural Economy.

Type of road:	Relationship to Rural economy	Relationship to the emergence and growth of new centres
All weather road, bound surface	Maximal increases opportunities for crop specialization, movement of agricultural feed etc.	Considerable Growth of major crossroads and terminal central places.
All weather roads loose surface	Considerable	Maximal as to number of emerging central places
Dry weather rural	Slight	Slight and decreasing
Motorable tracks	Minimal	Minimal

Adapted from D.N. McMaster (1965), Road communications and the pattern of Rural settlement. pp.15 "Towards a settlement Geography of Uganda".

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CHAPTER SIX

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.0 INTRODUCTION:

This chapter presents a summary of findings and conclusions based on the study undertaken. Recommendations and suggestions for future research in the area of rural transport infrastructure is also made.

This study was mainly concerned with the economic impacts of the feeder roads in the rural economy of Thika District. The results of this study have several implications for rural development in Kenya. The policy implications of the results of this study are presented here with a view to relating them to agricultural and rural development in the study area in particular and in rural areas of Kenya in general.

6.1 Rural Road Transport Infrastructure and Farm gate Prices of Agricultural Commodities

This study focused on the impacts of a selected feeder road on the farm gate prices of french beans. From the result of the study it was found out that the feeder road influenced significantly the farm gate prices of the agricultural commodity. Extending the results of this study we can generalise that rural feeder roads can significantly influence the farm gate prices of other agricultural commodity produce, especially horticultural products.

That the farm gate prices of agricultural commodities can be influenced by the provision of rural roads is a significant finding especially in rural development planning, in Kenya.

The implications of the above findings are that, in order to ensure that farmers in the rural areas get better prices for their products, there is a need to consider improvement in rural road infrastructure, in terms of network and surface quality characteristic. This is important because in the past the role of road infrastructure has often been under-rated as a significant factor in determining the farm gate prices of agricultural commodity produce.

6.1.1 Accessibility of major Retail Markets in the study area and Agricultural Commodity Prices

The results of this study found evidence to suggest that accessibility influences the price levels in the retail markets of Thika District. It was found that the most accessible markets generally had the highest price levels for similar commodities. The implications of these findings to rural development are obvious and clear. This means that in order to improve the price levels of agricultural commodity produce in the retail markets we need to improve the accessibility of these markets to the rural population. But accessibility in this case is a function of the road provision and road quality.

In order to achieve the above stated objectives, there will be a need to

provide a more dense network of roads and to improve the surface characteristics of the roads connecting these retail markets.

If improvement of the roads linking these retail markets is achieved, transport costs for inputs and outputs in the rural sector will significantly be reduced. All of these benefits will accrue to the farming community.

6.2 RURAL ROADS AND AGRICULTURAL LAND USE PATTERNS

Agronomic factors such as soil and climate have been widely recognised as some of the major spatial variables influencing regional land use patterns. This is understandable given that most of the crops grown have different requirements for their normal growth. Moreover, there are wide variations in land use patterns and therefore the cropping pattern in regions with the same resource endowment and even the same agronomic variables as indicated above. The reasons for these wide range of variation in land use patterns stem from a number of factors. In the rural areas of Thika District, particularly in the middle agro-ecological zones, it was hypothesised that household proximity to a main feeder road was a significant factor influencing horticultural land use among the farming community and more so among the small-scale farmers. The results of this study found evidence to the effect that indeed, accessibility to the main feeder roads influenced, significantly horticultural land use among the small-scale farmers.

It was seen in chapter four that the horticultural industry in Kenya has a lot of potential in raising the income levels of the rural households. This was also the case found in Thika District. Given that rural roads can greatly influence the alteration of the agricultural land use patterns, there is a need towards improving them, so that they can, among other things allow more farmers to put their land under commercial horticultural farming. This as has been detailed earlier, is more promising than reliance on other traditional cash crops in the area, namely coffee and tea.

The results of this study also show that road provision is an important component of attaining rural development, by enabling farmers to shift from the cultivation of low paying cash crops to high paying cash crops. Consequently, it can be generalised that provision of rural roads is an important element in aiding the transformation of farming communities from subsistence modes of production to cash crop farming.

6.2.1 Rural Roads Provision and High Value Cash Crops

The study found that the proportion of land under high value cash crops in each of the six divisions of Thika District was related to the road networks or the road density. There was a significant relationship or correlation between the size of land under high value cash crops and the road density in each of the six divisions of Thika District. This means that in order to increase the size of land

under high value cash crops, in the district, there will be a need to improve the road network in terms of length. This is important because raising the income levels of the rural population is a priority and objective, among our development goals.

If more land can be put under high value cash crops, especially horticultural crops, then farmers in the rural areas will have an alternative source of income. Furthermore this will diversify and intensify the income base of farmers.

6.3 THE ROLE OF RURAL ROADS IN THE GROWTH AND DEVELOPMENT OF NON-FARM ECONOMIC ACTIVITIES

It was found that rural roads have a significant role to play in the location and growth of non-farm economic activities, especially along these roads.

The study found that there was permanent and temporary roadside businesses established along the rural roads. These economic activities are numerous and varied. The importance of these activities stem from their potential in creating alternative employment opportunities in the rural areas and thereby raising the levels of income for those engaged. Furthermore, these rural non-farm economic activities are seen as alternative opportunities for growth in the rural sector.

It was also found that accessibility of rural trading and market centres

significantly influences the structure of non-farm activities in these centres. The implication of these findings is that, to promote the growth of non-farm economic activities in the rural areas, there is a need to improve accessibility of these centres defined in terms of road surface quality and connectivity characteristic. If this is achieved, it will positively influence the location, growth and development of the rural non-farm economic activities. This is important in employment generation and in achieving balanced rural-urban interaction. This will ensure that the urban sector supports the rural sector, and conversely.

6.4 POLICY IMPLICATIONS

It is indicated here, on basis of the study undertaken that the development of rural road infrastructure has to play a key role in any development strategy for rural areas of Kenya. Such a strategy must aim at growth and equity.

A development strategy for growth and equity will place priority on agriculture and non-farm economic activities in the rural areas. The emphasis on agriculture is understandable because agriculture is the major source of income for the rural people most of whom are poor. In order for this vast majority to participate in the process of development, agriculture has to be given priority.

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In a country where agricultural land is limited, and the pressure of population on land is so high, surplus labour in agriculture must be accommodated through expansion of the non-agricultural sector in the long run. Employment oriented activities are therefore another component of development strategy that will aim for growth with equity. The growth and development of the non-farm activities which, as has been seen, show clear preference for roads, will therefore be a major component in rural development.

Instead of planning transport in isolation a systems approach to agricultural development is essential to link transport policy with the goals that transport is called upon to serve. In this case to increase the production and marketing of agricultural products. Success will therefore call for concerted efforts at both local and national levels. An important requirement will be flexibility in plans aimed and improving rural road transport and in the use of development funds for this purpose.

A systems approach is needed for transport and agriculture. This approach should move away from constructing roads for the sake of transport and instead concentrate on the objectives of agricultural production and rural development. Investments need to be programmed as apart of package of things that separately may produce the food that is essential to survival of rural population. The government should improve accessibility. By providing and improving accessibility, people and goods or products will be able to move from

one place to another.

Improving transportation will increase the rate and frequency of movement and if this takes place in the rural areas, then development innovation are likely to reach these areas much faster and thereby enhance rural development.

Rural areas are lagging behind in our country and this is partly because they lack the major development factors, such as adequate road infrastructure. Therefore, there is a need to change from the emphasis which has been laid down on improving trunks roads, such that after 30 years of independence, we still have not changed much from this set up.

The trunk roads that have been built have led to ribbon development along them. Among the main roads in the rural areas, spatial development is hardly beyond a walking distance of five kilometres on either side of the road. This means that besides tapping the rural resources, the roads have had nothing to do with integration of rural or regional areas.

In Thika district for example only 6.3 per cent of the total roads are surfaced and these are mainly the national trunk roads. While the rest of the roads comprising 93.7 per cent are just gravel, murram or dirt earth roads. Yet these are the roads which penetrate into the rural areas. For rural development to be accelerated it will be necessary that such roads be given priority in improvements and better inter-connection between regions be made.

6.5 DONOR POLICIES ON INFRASTRUCTURE

Infrastructure development in Kenya has historically been greatly influenced by the foreign aid policies of donors. The World Bank's emphasis on high priority for infrastructure development reached its peak during 1960s and then began to drop drastically. For instance, the transport sector's share of World Bank lending dropped from 35 per cent in 1970-74 to 17 per cent in 1980-84. By 1990, these figures had declined significantly to less than 10 per cent.

The donors should recognise the pivotal role played by infrastructure especially rural roads infrastructure in economic development of developing countries and should review their lending for infrastructural development. The donors should also change from attaching a declining priority to infrastructure development in less developed countries.

It is also recommended that the government should take more initiative in the promotion of rural transport infrastructure using donor funds. This will assist in overcoming the isolation of rural farm areas. The dualism that finds inter-city and inter-urban transport becoming increasingly modern and rural transport standing still should be avoided. A shift in emphasis to promotion of rural transport infrastructure could help provide the rural-urban links essential to the transformation of agriculture. Unless these links are strengthened, the success of other efforts will still provefutile to the task of averting decline in agricultural

production.

6.5.1 Recommendations

This study focused mainly on some economic impacts of rural roads infrastructure in Thika district. The findings of this study present some significant results. From these results several recommendations can be made. These recommendations fall under two broad categories, namely:

1.   Those directed towards researchers

2.   Those directed towards the government, the planners and policy makers

6.5.2 Researchers

The recommendation made to the researchers are in the form of suggested future research areas. These are the areas that the researcher feels need more attention. These are:

1.   There is a need to conduct research in the rural areas to determine how the prices of agricultural inputs such as fertilizers vary from different villages in relation to accessibility.

2.   This study focused mainly on economic impacts of rural roads, as a result of which social variables were for the most part not considered. It is therefore appropriate to conduct an empirical study to examine how travel characteristic in the rural areas are influenced by provision of roads.

3. It is also worth undertaking a study to examine how general infrastructure in the rural areas influences development in the villages. Such studies would examine how infrastructural growth affects both rural and agricultural development.

4. A study should also be undertaken to examine the relationship between agricultural production and transport system. Studies of this nature should be conducted at local levels where data permit such undertakings.

5. There is also a need to conduct a study in all rural districts in Kenya to examine the road network and its impact on the growth of infrastructure. This is an un-explored area and a neglected area in academic research.

6.5.3 Recommendations to Planners and Policy Makers

1. In an effort towards promoting rural and agricultural development planners and policy makers should aim at developing the road network given that it has a major impact on the growth of other infrastructural facilities such as rural markets .

2. The planners and the policy makers in the government should take a leading role in ensuring that there is a rural-urban balance. In order for this to be achieved, the government will need to promote the growth of a road network in the rural areas. This is because, the road network is the main channel through which people and commodities are propelled.

3. It is our government stated objective of reducing poverty in the rural areas of our country. Given this undertaking, concerted efforts need to be made to determine how income levels in the rural areas can be improved. The planners and policy makers should give priority to the improvement of accessibility in the rural areas. This is understandable given that it has already been established that farm gate prices for agricultural commodities can vary due to differences in the levels of accessibility.

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APPENDIX 1

UNIVERSITY OF NAIROBI

Department of Geography

LAND USE AND FARM GATE PRICES SURVEY IN RELATION TO FEEDER ROAD FACILITIES.

1. Name of respondent _____
    Village _____
    Location _____
    Division _____
2. Primary Occupation of respondent.
    1. Farmer
    2. Non-farm activities.
3. Size of land holding in hectares. _____
4. Nature of land ownership
    1. Freehold
    2. Leasehold
    3. Others
5. Do you grow horticultural crops in your farm?
    1. Yes
    2. No
6. Do you grow French Beans in your farm?
    1. Yes
    2. No
7. If yes estimate the size of your land under French beans cultivation

    Size_____
8. French Beans are grown under
    1. Irrigation
    2. Rainfall water
9. Estimate the quantity in Killogrammes of french beans produce per year.

10. The French Beans are grown for
    1. Consumption
    2. Sale
11. The French Beans produced are sold to:
    1. Middlemen
    2. Export Companies (Direct)
    3. Others
12. Are the French Beans Produced collected at the farm.

1. Yes
2. No

13. State the average price per Kilogramme of french Beans
    1. 1 - 5
    2. 6 - 10
    3. 10 - 14
    4. 15+

14. Do Villages/households farms located near the main feeder road get better prices for the french beans produce than those located far from the road.
    1. Yes
    2. No
    3. Don't know

15. From the list below tick what you consider to be the most serious problem affecting french beans produce in your area.
    1. Poor/inadequate transport facilities.
    2. Price Fluctuation
    3. Lack of adequate inputs.
    4. Lack of produce organisation
    6. Others

16. Approximate Distance of farm/village from main feeder road (Thika- Kirwara Road) in Kilometres ....

17. Approximate the proportion of land taken by all horticultural crops including french beans
    1. <25 %
    2. 25 - 60 %
    3. >60 %

APPENDIX II

UNIVERSITY OF NAIROBI

DEPARTMENT OF GEOGRAPHY

QUESTIONNAIRE SCHEDULES USED FOR SURVEY OF THE INFLUENCE OF RURAL FEEDER ROADS ON ROADSIDE ECONOMIC ACTIVITIES.

1. Name of respondent   Village_____

    Location _____

    Division _____

2. Sex 1. Male

    2. Female

3. Age in years

    1. 5-14

    2. 15-24

    3. 25-34

    4. 35>

4. Division where you come from

    1. Gatanga

    2. Kamwangi

    3. Gatundu

    4. Kakuzi

    5. Ruiru

    6. Thika

5. Type and Nature of Roadside (Business) Economic activity

    1. Vegetable vendor

    2. Blacksmith

    3. Tea Kiosk

    4. Bicycle repair

    5. General Shop

    6. Shoe repair

    7. Others

6. State the nature of the road in which the roadside   business activity is located.

    1. Loose surface (dirt) weather road.

    2. Loose surface murram/gravel road

    3. All weather road bound (bitumen) surface

7. Is the roadside business located at crossroads.

    1. Yes

    2. No

8. Is your home located in land fronting/bordering the road

    1. Yes

    2. No

9. Approximate range of income (in Ksh) earned per year from   the roadside business.

    1. 0 - 5,000

    2. 5 - 10,000

    3. 10,000>

10. State the number of people employed in your business.

    1. 1-2

    2. 2-5

    3. 6>

11. Is your business premise structure permanent of temporary

    1. Permanent

    2. Temporary

12. Why did you locate your business along the road

    1. Personal preference

    2. Accessibility to customers

    3. Ease of transport services

    4. Own land fronting the road

13. Do passenger vehicle operate regularly along the road where your business is located.

    1. Yes

2. No

14. Mode of transport commonly used by customers to reach your business

1. Vehicles

2. Walking

15. Customers for the business are drawn from

1. Local area

2. Others

APPENDIX 3
LIST OF TRADING/MARKET CENTRES IN THIKA DISTRICT

1.	Mukinye	31.	Magomano	61.	Kabere
2.	Kairi	32.	Ngenda	62.	Kariua
3.	Mukurwe	33.	Mutati	63.	Ita-kiarie
4.	Kamwangi	34.	Kagaita	64.	Ria karime
5.	Mataara	35.	Kanyoni	65.	Muthiga
6.	Mbogoro	36.	Gatukuyu	66.	Roi
7.	Mariani	37.	Kamunyaka	67.	Gathunguchu
8.	Gitati-ini	38.	Kiamwangi	68.	Gathaithi
9.	Gituamba	39.	Ritho	69.	Kimunyu
10.	Kiamwathi	40.	Mutono	70.	Kigongo
11.	Gathuitu	41.	Nembu	71.	Kamwangi
12.	Njatha-ini	42.	Kiriko	72.	Gikune
13.	Gathiru	43.	Kahuguni	73.	Mbichi
14.	Muba-u-ini	44.	Chania	74.	Mugutha
15.	Ituramiro	45.	Ngorongo	75.	Gate
16.	Gathage	46.	Kamworia	76.	Kanjuku
17.	Gatundu	47.	Kairi-ini	77.	Ita-Ndege
18.	Igamba	48.	Miiri	78.	Mugomo-ini
19.	Nyamanyara	49.	Gachege	79.	Kihumbui-ini
20.	Karinga	50.	Makwa	80.	Chomo
21.	Ndudu	51.	Gatitu	81.	Gatutu
22.	Miteero	52.	Gatuna maru	82.	Kiunyu
23.	Karure	53.	Gakoe	83.	Mukurwe
24.	Ituru	54.	Mundoro	84.	Kiriari
25.	Gitwe	55.	Mutoma	85.	Gatanga
26.	Gachika	56.	Karatu	86.	Mununga
27.	Ngethu	57.	Kirangi	87.	Mabae
28.	Mbagathi	58.	Mutiiguru	88.	Kigio
29.	Gacharage	59.	Kagongo	89.	Ithangarari
30.	Kangoo	60.	Gakui	90.	Gatuikira

91.	Gatuikira	104.	Matunda
92.	Mbari-ya-igi	105.	Ngatho
93.	Ndakaini	106.	Ngeleha
94.	Kigoro	107.	Kititu
95.	Kanunga	107b.	Gakoe
96.	Kia-rutara	108.	Munyu
97.	Kimandi	109.	Mbagathi
98.	Gatakaini	110.	Ndura
99.	Kiganjo	111.	Muthera
100.	Ithangaga	112.	Mang'u
101.	Kinyangi	113.	Kilimambog
102.	Kirimiri	114.	Ruiru
103.	Ngoliba		

CORRELATION ANALYSIS AND REGRESSION OUTPUT DATA

CORRELATIONS /VARIABLES V16 WITH V9 V13.

Correlations: V9   V13

  V16   .1417   -.8708**

N of cases: 120   1-tailed Signif: * - .01 ** - .001

" . " is printed if a coefficient cannot be computed

CORRELATIONS /VARIABLES V17 WITH V16.

Correlations: V16

  V17   -.9463**

N of cases: 120   1-tailed Signif: * - .01 ** - .001

CORRELATIONS /VARIABLES V7 WITH V9.

Correlations: V9

  V7   .7511**

N of cases: 120   1-tailed Signif: * - .01 ** - .001

REGRESSION /VARIABLES V16 V9 V13 /DEPENDENT V13 V13 /METHOD ENTER.

Bivariate Regression

Equation Number 1   Dependent Variable.. V13   price

Variable(s) Entered on Step Number

  1.. V9   quantity

  2.. V16   distance

Multiple R   .87270

R Square   .76161

Adjusted R Square   .75754

Standard Error   2.65801

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	2	2640.85980	1320.42990

Residual   117   826.60687   7.06502

F ≈   186.89694   Signif F = .0000

Variables in the Equation

Variable   B   SE B   Beta   T   Sig T

V9   6.103608E-04 4.82314E-04   .05770   1.265 .2082

V16   -1.92355   .09979   -.87901 -19.277 .0000

(Constant) 15.89417   .53594   29.657 .0000

Bivariate Regression

REGRESSION /VARIABLES V13 V16 /DEPENDENT V13 /METHOD ENTER.

Equation Number 1   Dependent Variable.. V13   price

Variable(s) Entered on Step Number

  1.. V16   distance

Multiple R   .87083

R Square   .75835

Adjusted R Square   .75630

Standard Error   2.66478

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	2629.54555	2629.54555
Residual	118	837.92112	7.10103

F =   370.30499   Signif F = .0000

Bivariate Regression

Equation Number 1   Dependent Variable.. V13   price

——————— Variables in the Equation —————

```
Variable     B      SE B     Beta      T  Sig T
V16    -1.90565   .09903   -.87083  -19.243 .0000
(Constant) 16.24478  .45994           35.320 .0000
```

* * * *MULTIPLE REGRESSION * * * *

REGRESSION /VARIABLES V17 V16 /DEPENDENT V17 /METHOD ENTER.

Listwise Deletion of Missing Data

Equation Number 1   Dependent Variable.. V17   horticultural land

* * * * MULTIPLE REGRESSION * * * *

Equation Number 1   Dependent Variable.. V17   horticultural land

Variable(s) Entered on Step Number
  1.. V16   distance

Multiple R   .94631
R Square   .89549
Adjusted R Square   .89461
Standard Error   .28667

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	83.09445	83.09445
Residual	118	9.69721	.08218

F = 1011.13031   Signif F = .0000

* * * * MULTIPLE REGRESSION * * * *

Equation Number 1   Dependent Variable..   V17   horticultural land

—————— Variables in the Equation ——————

Variable	B	SE B	Beta	T	Sig T
V16	-.33876	.01065	-.94631	-31.798	.0000
(Constant)	3.29360	.04948		66.566	.0000

**** M U L T I P L E   R E G R E S S I O N ****

REGRESSION /VARIABLES V3 V16 V17 /DEPENDENT V17 /METHOD ENTER.

Listwise Deletion of Missing Data

Equation Number 1   Dependent Variable..   V17   horticultural land

**** M U L T I P L E   R E G R E S S I O N ****

Equation Number 1   Dependent Variable..   V17   horticultural land

Variable(s) Entered on Step Number
   1..   V16   distance
   2..   V3   land size

Multiple R   .94646
R Square   .89578
Adjusted R Square   .89400
Standard Error   .28750

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	2	83.12093	41.56047
Residual	117	9.67073	.08266

F = 502.81346   Signif F = .0000

**** M U L T I P L E   R E G R E S S I O N ****

Equation Number 1   Dependent Variable.. V17   horticultural land

————————— Variables in the Equation —————————

Variable	B	SE B	Beta	T	Sig T
V16	-.33897	.01069	-.94691	-31.706	.0000
V3	8.379750E-03	.01481	.01690	.566	.5725
(Constant)	3.27801	.05675		57.758	.0000