FARMING-RELATED TRANSPORT NEEDS AND
PROVISION IN MWEA TEBERE IRRIGATION SCHEME,
KIRINYAGA DISTRICT, KENYA

Susan Wanjiru Mbuthia

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Kenyatta University, Department of Geography

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DECLARATION

This thesis is my original work and has not been presented for a degree or any other award in any other university.

Signature: ~

Susan Wanjiru Mbuthia (Candidate)

Date: 2014.02

This thesis has been submitted with an approval of university supervisors.

Signature: ~

Dr. Dorothy N. Mutsya

Date: 12.5.2003

Signature: ~

Dr. Meleckidzedezek Khayesi

Date: 22.4.2003
DEDICATION

To my parents, Wanjiku and Mbuthia Gitata, for their love that moved them to do all they have done for me.
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ABSTRACT

This study analyses farming related transport needs and provision in Mwea Tebere Irrigation Scheme, Kirinyaga District, Kenya. The objectives of the study are to: (a) describe the basic transport features at the farm level, (b) examine how farmers meet their agricultural transport needs, (c) identify and determine the type, severity and effects of transport constraints faced by farmers on farming related activities and (d) discuss the farmers’ efforts in overcoming the transport constraints facing them. The following hypotheses are tested in this study: (a) there is no significant difference in average trip lengths travelled daily by farmers in different sites of Mwea Tebere Irrigation Scheme, (b) there is no significant difference in average time spent on farming related movement in different sites in Mwea Tebere Irrigation Scheme, (c) there is no significant difference in average time spent on farming related movement by men and women in Mwea Tebere Irrigation Scheme, (d) there is no significant difference in average distances covered between the homestead and the farm by farmers in Mwea Tebere Irrigation Scheme, (e) there is no significant difference in the means of transport used by men and women, and (f) there is no discernible pattern in rating of transport constraints experienced by farmers in Mwea Tebere Irrigation Scheme.

Data for this study were collected by the use of a space-time movement frequency matrix, a questionnaire and focus group discussions. The Statistical Package for Social Science (SPSS) version 6.3 was used for data processing and analysis. The following statistics and tests were used to summarize the data and test the hypotheses: mean, percentages, frequencies, chi-square test, student’s t-test, analysis of variance (ANOVA) and factor analysis. The results were presented using tables and photographs.

ANOVA test reveals that there is a significant difference in the average distance travelled daily by farmers. The test also indicates that there is no significant difference in average time spent on farming related movement in Mwea Tebere Irrigation Scheme. The student’s t-test analysis indicates that men spend more time than women do on farming related movement. Chi-square test reveals that there is a significant difference in the means of transport used by men and women. The factor analysis demonstrates a discernible pattern in the rating of transport constraints by farmers. These constraints are identified and labeled as: administrative and management constraint, financial constraint, inaccessibility, load transport constraint, poor road infrastructure and inadequate motor vehicle services.

The overall effect of these constraints is delay in performance of farm activities, leading to less farm production. To overcome the transport constraints they
face, farmers have adopted two main coping strategies: use of non-motorised means of transport and reducing the number of visits to the market. Whereas these coping strategies are important to the farmers they could still be improved. It is, therefore, recommended that: the current Irrigation Act should be reviewed to address the existing farming related transport needs of farmers, non-motorised means of transport, particularly the bicycle, be modified and all the stakeholders (government, farmers, traders) in the transport service in Mwea Tebere Irrigation Scheme be involved in construction, repair and maintenance of roads within the Scheme.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Acknowledgements</th>
<th>iv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstract</td>
<td>vi</td>
</tr>
<tr>
<td>List of Tables</td>
<td>xii</td>
</tr>
<tr>
<td>List of Figures</td>
<td>xv</td>
</tr>
<tr>
<td>List of Plates</td>
<td>xv</td>
</tr>
</tbody>
</table>

## CHAPTER 1

### INTRODUCTION

| 1.1 Background to the Research Problem | 1 |
| 1.2 Statement of the Research Problem | 7 |
| 1.3 Research Questions               | 9 |
| 1.4 Research Objectives              | 9 |
| 1.5 Research Hypotheses              | 10|
| 1.6 Justification for the Study      | 11|
| 1.7 Scope and Limitations of the Study | 13|
| 1.8 Definition of Key Concepts and Terms | 13|
| 1.9 The Study Area                   | 15|
| 1.9.1 Location                       | 15|
| 1.9.2 A Brief History of Mwea Tebere Irrigation Scheme | 16|
| 1.9.3 Physical Environment           | 19|
| 1.9.3.1 Climate                      | 19|
| 1.9.3.2 Soils                        | 20|
| 1.9.3.3 Topography                   | 20|
| 1.9.4 Human Environment              | 21|
| 1.9.4.1 Settlement and Population    | 21|
| 1.9.4.2 Crop Production              | 21|
| 1.9.4.3 Transport                    | 23|
| 1.10 Rationale for the Choice of the Study Area | 23|
CHAPTER 2
REVIEW OF LITERATURE 25

2.1 Introduction 25
2.2 Rural Transport Needs and Travel Characteristics 25
2.3 Rural Transport Constraints 31
2.4 Rural Transport Planning 33
2.5 Theoretical Framework 37
2.5.1 Bases of Spatial Interaction 37
2.5.2 Transport Component in Agricultural Land Use Location Theory 40
2.6 A Conceptual Model of Farming Related Transport Demand and Supply 41

CHAPTER 3
RESEARCH METHODOLOGY 46

3.1 Introduction 46
3.2 Sampling Design 46
3.3 Data Collection 47
3.3.1 Problems Encountered in Data Collection 49
3.4 Data Processing and Analysis 51
3.5 Hypotheses Testing 51
3.5.1 Chi-square Test 52
3.5.2 Student's t-test 54
3.5.3 One-way Analysis of Variance 55
3.5.4 Factor Analysis 56

CHAPTER 4
STRUCTURE OF FARMING RELATED MOVEMENT IN MWEA TEBERE IRRIGATION SCHEME 60

4.1 Introduction 60
4.2 Range of Movement 61
4.3 Time Spent on Farming Related Movement 67
CHAPTER 5
ORGANISATION AND PROVISION OF TRANSPORT SERVICE TO FARMERS IN MWEA TEBERE IRRIGATION SCHEME

5.1 Introduction
5.2 Provision of Transport Service
5.2.1 Government Sector through the National Irrigation Board
5.2.1.1 Transport of Inputs by National Irrigation Board
5.2.1.2 Transport of Rice
5.2.2 The Private Sector
5.2.2.1 Farmers’ Co-operative Society
5.2.2.2 Individual Transport Arrangements
5.2.2.2.1 Human Porterage
5.2.2.2.2 The Bicycle
5.2.2.2.3 Animal Transport
5.2.2.2.4 Motor Vehicle Transport
5.2.2.3 Itinerant Traders
5.3 Summary

CHAPTER 6
TRANSPORT CONSTRAINTS, THEIR EFFECTS AND FARMERS’ STRATEGIES OF MANAGING THESE CONSTRAINTS

6.1 Introduction
6.2 Farmers’ Assessment of the Severity of Transport Constraints and their Effects on Farming
6.3 Factor Analysis of the Transport Constraints
6.4 Strategies Used by Farmers to Overcome the Transport Constraints
6.5 Summary

CHAPTER 7
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

7.1 Introduction
7.2 Summary of the Main Findings
7.3 Conclusion
7.4 Recommendations
7.5 Suggestions for Further Research

REFERENCES

APPENDICES

Appendix 1: Farm Survey Questionnaire
Appendix 2: Space-Time Movement Frequency Matrix of Household Members
Appendix 3: Guide for Focus Group Discussion
LIST OF TABLES

Table 1.1: Rice Production in the Four Large Scale Rice Growing Irrigation Schemes in Kenya, 1993/94 – 1997/98 (in tones) 6

Table 2.1: Trip Purposes 26

Table 2.2: Travel Range 27

Table 2.3: Means of Transport 29

Table 2.4: Transport Constraints 32

Table 3.1: Description of Research Variables 47

Table 4.1: Daily Trip Lengths by Site 61

Table 4.2: Results of Analysis of Variance on Distance Travelled by Site 62

Table 4.3: Trip Lengths Travelled Daily by Men and Women 64

Table 4.4: Trip Length by Means of Transport Used 65

Table 4.5: Distance Between the Homestead and the Farm Plot 66

Table 4.6: Average Distance (kms) Travelled between Homestead and Farm Plot 66

Table 4.7: ANOVA Results of Distance Travelled Between Homestead and Farm 67
<table>
<thead>
<tr>
<th>Table 4.8:</th>
<th>Average Time Spent on All Movements and Farming Related Movement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Table 4.9:</td>
<td>Daily Time Allocation to Various Activities by Farmer A</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Table 4.10:</td>
<td>ANOVA Test Results of Time Spent on Farming Related Movement</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Table 4.11:</td>
<td>Average Time Spent on All Movements and Farming Related Movement by Means of Transport Used</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Table 4.12:</td>
<td>Average Time Spent on All Movements and Farming Related Movement by Sex</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Table 4.13:</td>
<td>T-test Results for Time Spent on Farming Related Movement by Men and Women</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Table 4.14:</td>
<td>Average Amount of Crop Yields for the 1998/99 Crop Year</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Table 4.15:</td>
<td>Load Size of Farm Implements, Inputs and Outputs Carried Daily</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Table 4.16:</td>
<td>Means of Transport Used by Nature of Route</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Table 4.17:</td>
<td>Means of Transport Used by Sex</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Table 4.18:</td>
<td>Chi-square Results of Means of Transport Used by</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6.1: Rating of Transport Constraints by Respondents

Table 6.2: Product-Moment Correlation Matrix Among Variables (Transport Constraints) Faced by Farmers

Table 6.3: Unrotated Factor Structure Matrix

Table 6.4: Varimax Rotated Factor Matrix
LIST OF FIGURES

Figure 1.1: Location of Mwea Tebere Irrigation Scheme 17

Figure 2:1: Farming Related Transport Situation 42

Figure 6.1: Scree Slope Graph 106

LIST OF PLATES

Plate 5.1: Women Carrying Bags of Maize on their Backs to the Market in Mwea Tebere Irrigation Scheme 87

Plate 5.2: A Bicycle Rider Transporting a Bag of Rice to the Market. 88

Plate 5.3: Ox-drawn Cart Transporting Goods from the Market to the Farmers’ Residential Areas (Villages) 91

Plate 5.4: A Matatu Transporting Goods and Passengers to Makutano Market 93

Plate 5.5: A Pick-Up Used by Middlemen for Collecting and Transporting Tomatoes from the Farm-Gate 94

Plate 5.6: A Lorry Used by Itinerant Traders for Transporting French Beans. 94
CHAPTER 1
INTRODUCTION

1.1 Background to the Research Problem

Transport plays an important role in the movement of people and goods as well as the overall socio-economic development of any country. Mobility is an important element that allows and perhaps accelerates development, while restricted mobility is inevitably a brake on the development of any society (Hoyle, 1988; Hoyle and Knowles, 1992). Economic development is directly influenced by the following four important factors (White and Senior 1983):

(a) division of labour; this brings about specialisation of each group on what it can do best. For example, a group of people may concentrate on sugarcane farming while another specialises on processing this product. As a result, the two groups depend on each other to carry out their complementary activities. Transport comes in to bridge the gap between the groups: producers and processors.

(b) areal specialisation; economic advancement of a place depends on its specialisation in the activities most closely adapted to its environment and resources. For example, the economic activity around lake Victoria in Kenya is mainly fishing while that in the Kenya’s highlands is crop farming. Such specialisation means greater interdependence between areas and upon transport to bridge the spatial gap in resource surplus and deficits.
(c) extension of market; market can be extended by increasing demand in volume, in variety and in geographical area of sales. This can be achieved by linking the producer to the consumer through transport.

(d) optimisation of production units. The ability of a firm to minimise production costs by reducing optimal size is controlled by the extent of the market. Production will be increased only if there is a market and transport facility to supply the market.

Transport emerges as an important service in the four factors outlined above. Thus, transport is important in economic functioning and development of a society (White and Senior, 1983). Indeed, without transport, social and economic activities of a society may only be possible on a subsistence or local exchange basis. Hence, improved transport broadens the economic opportunities available to people.

At the household level, transport facilitates access and acquisition of needs such as food, water, energy, education, employment, recreation and health care as these services are offered in different locations (Kaira, 1983; Ogendi, 1992; Khayesi, 1993,1990; Barwell, 1996; Sieber, 1997; Tichagwa, 2000). Transport therefore plays an important role in spatial interaction and human welfare.

Transport has been identified as important in poverty reduction (Howe, 1996; Tichagwa, 2000). Ogendi (1992), Nalo (1994) and Howe (1998) argue that
involving the community in road construction and maintenance in their locality contributes to employment-creation and income-generation. Also, the distribution of essential services such as health, education and farm inputs and the disposal of agricultural surpluses by the rural people are further improved by efficient transport. Households located in close proximity to transport routes are better served than those that are isolated. This explains why development seems to be concentrated along transportation routes (Madungha, 1975; Ogonda, 1986; Nyaga, 1991). Consequently, people migrate from isolated regions to settle next to new transport routes (Chiteji, 1980). As transport routes open up a region, mobility of the people in such a region is promoted and they can secure employment in the more advanced regions. The wages earned are used to meet other needs such as buying of goods, clothing, building better shelter, paying for medical care and school fees and going for recreation.

Transport is vital for the development of the agricultural sector. Agriculture is the backbone of the economy of Kenya. The agricultural sector, like other sectors of economy, requires an efficient transport system. Transport routes link the agricultural producer to the market (Odero, 1997; Odhiambo, 1998). Transport is required for the movement of farm inputs and outputs. Hoyle (1988) and Mwase (1991) argue that efficient transport at every scale, from the local to the global, can help a country to market and/or distribute its agricultural produce efficiently and competitively. For example, transport is an important service in distribution of relief food from suppliers to the affected areas (Pirie,
Transport is also necessary for the flow of innovations to farmers. Efficient transport reduces farm losses, especially of highly perishable crops.

Although it is difficult to quantify comprehensively the impacts of transport on agricultural development, the significance of transport service in agriculture cannot be overemphasised (Kamulali, 1977; Chiteji, 1980; Ogendi, 1992; Barwell, 1996; Atieno, 1997; Odero, 1997; Sieber, 1997). Where transport is inadequate, agricultural development is affected: farm inputs and outputs cannot be moved easily, large tracts of arable land are not fully utilised and diffusion of innovations is limited (Porter, 1998; Spore, 1998).

A number of studies have identified transport constraints to agricultural development (Kamulali, 1977; Chiteji, 1980; Riverson and Carapetis, 1991; Barwell, 1996; Atieno, 1997; Odero, 1997; Sieber, 1997). These constraints are experienced in varying degrees in Kenya's agricultural areas (Kaira, 1983; Ogendi, 1992; Nalo, 1994; Ombui, Arimi, McDermott, Mbugua, Kakuko and Kilungo, 1995; Kenya, 1997a; Odero, 1997). For example, rural and feeder roads connecting villages and farming areas to each other and to market centres are usually inadequate, poorly maintained and costly to use. The feeder roads are generally narrow and impassable during the rainy season (Kenya, 1997a; Mwase, 1991). This makes movement of goods and people difficult, particularly during the rainy seasons when most roads are impassable. Consequently, the cost of production increases.
Poor and inadequate rural transport services that arise due to low supply of motor vehicles, lack of intermediate means of transport and appropriate infrastructure lead to dependence on human porterage, which is arduous and uneconomical. Human porterage is slow and therefore time-consuming and can cause injury as well as losses in farm produce, particularly the perishable goods.

One of the agricultural sectors that requires efficient transportation is irrigation farming as crop production is continuous throughout the year because of availability of water. However, crop production is undermined by the existence of the transport constraints outlined above. This is the case in Mwea Tebere Irrigation Scheme where different crops such as rice, tomatoes, French beans, maize, green grams and beans are grown, leading to variation in transport demand and supply of transport services.

Mwea Tebere Irrigation Scheme is one of the large–scale irrigation projects in Kenya. It was started in 1952 to improve agricultural production and to alleviate poverty (Chambers and Moris, 1973). While the other large-scale irrigation schemes such as Bura, Ahero, Bunyala, Kano and Perkerra have been described as having failed, Mwea Tebere Irrigation Scheme has been described as successful (Ruigu, 1988; Ruigu and Rukuni, 1990; National Irrigation Board, 1993). Its success is partly reflected in its production and supply of about 80% of the rice consumed in Kenya. Also, compared to other large-scale rice growing irrigation schemes, Mwea Tebere Irrigation Scheme realises the highest overall
production (Table 1.1), supplying the other rice schemes with seeds. Whereas, other large-scale irrigation schemes depend on the government for their operations, Mwea Tebere Irrigation Scheme is able to sustain its operations.

Table 1.1: Rice Production in the Four Large-scale Rice Growing Irrigation Schemes in Kenya, 1993/94 – 1997/98 (in tonnes)

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<td>Mwea Tebere</td>
<td>24205</td>
<td>24892</td>
<td>25987</td>
<td>27488</td>
<td>21352</td>
</tr>
<tr>
<td>Ahero</td>
<td>2712</td>
<td>1993</td>
<td>2054</td>
<td>412</td>
<td>968</td>
</tr>
<tr>
<td>West Kano</td>
<td>2997</td>
<td>1726</td>
<td>1645</td>
<td>2847</td>
<td>1606</td>
</tr>
<tr>
<td>Bunyala</td>
<td>1073</td>
<td>917</td>
<td>920</td>
<td>812</td>
<td>728</td>
</tr>
</tbody>
</table>

Source: Kenya (1999a: 120)

Although rice production has shown a consistent upward trend in Mwea Tebere Irrigation Scheme, a decline was recorded in the 1997/98-crop year. This decline in the output is partly attributed to “diversion of produce sales to private traders” (Kenya, 1999a: 120).

The success of Mwea Tebere Irrigation Scheme is attributed to the continuous gravity-fed water supply, favourable soils and climate, and location just a few kilometres from the major all-weather Embu-Nairobi road and rail connections (Chambers and Moris, 1973). Whereas it is true that the Scheme is advantaged by having easy access to the Embu-Nairobi road and the rail connections, it is questionable the extent to which individual farmers benefit from proximity to these modes of transport as far as farm level transport situation is concerned. This question is relevant in view of an observation from a growing body of transport studies that although rails and all-weather roads are important links
locally, regionally and nationally, their presence in a region does not necessarily mean that transport needs of rural households are automatically and efficiently met (Kaira, 1983; Khayesi, 1993; Howe, 1996; Tichagwa, 2000). Hence, the need to examine the prevailing farming related transport situation in Mwea Tebere Irrigation Scheme.

1.2 Statement of the Research Problem

Mwea Tebere Irrigation Scheme is centrally managed. The National Irrigation Board manages most of the activities related to rice production. The Board arranges for almost all transport services needed in rice production by farmers at a fee. A farmer is, however, entitled to retain 12-16 bags of rice for his/her subsistence and/or commercial use (Tsuruuchi and Waiyaki, 1995; Shagavah, 1998). Transportation of this rice from the farm plot to the farmer’s homestead and to the market is entirely his/her responsibility.

There are other crops such as tomatoes, French beans, maize, beans and green grams produced by farmers in the Scheme, independent of the management of the National Irrigation Board. The production of these other crops, just as is the case for rice, involves enormous use of inputs such as labour, fertiliser, pesticides and water. All the arrangements for transport related to the production of these crops are entirely the farmer’s responsibility. This gives rise to varying and sometimes complementary transport arrangements in the Scheme where the
National Irrigation Board and farmers are responsible for the transport of agricultural produce and inputs at different levels. The crops grown in Mwea Tebere Irrigation Scheme have different maturing periods. Thus, the harvesting and marketing periods are varied, leading to variation in demand, duration and provision of transport services.

Although there is a growing body of studies on transport and agriculture in Kenya (for example, Mbwesa, 1988; Khayesi, 1990; Ogendi, 1992; Odero, 1997), it is noted that an in-depth analysis of farming related transport needs and provision particularly in the irrigation schemes has been given little attention in research. Most of the information on farming related transport in these studies is general in nature. Whereas the general economic situation in Mwea Tebere Irrigation Scheme has been studied by, among others, Chambers and Moris (1973), Ruigu (1988) and Tsuruuchi and Waiyaki (1995), the transport burden facing farmers has not been examined. This is so despite the fact that transport could be influencing the economic situation in Mwea Tebere Irrigation Scheme.

The basic transport problem in Mwea Tebere Irrigation Scheme which requires investigation and intervention, is inefficient short distance travel for farmers. The purpose of this study is therefore to examine farming related transport needs and provision in Mwea Tebere Irrigation Scheme, Kirinyaga District, Kenya. This study focuses on four main aspects: First is an analysis of the basic features of farming related movement. The following features are examined: trip length,
time spent in mobility, nature of routes used, means of transport used and amounts of load carried. Second is an examination of the provision of transport services to farmers. Third is an investigation of farmers' assessment of the severity of transport constraints they experience and the effects of these constraints on farming. Fourth is an examination of efforts made by the farmers to overcome the transport constraints they face.

1.3 Research Questions

The following research questions are addressed in this study:

(a) What are the basic features of farming-related movement in Mwea Tebere Irrigation Scheme?
(b) How do farmers meet their transport needs?
(c) What pattern emerges from the farmers' rating of severity of the transport constraints they face and what are their effects on farming?
(d) What efforts have the farmers made to overcome the transport constraints they face?

1.4 Research Objectives

The broad theme of this study is to show the relationship between transport and agriculture. The specific objectives are to:
(a) describe the basic features of farming related movement in Mwea Tebere Irrigation Scheme.

(b) examine how transport is organised to meet the needs of farmers in Mwea Tebere Irrigation Scheme.

(c) Identify and determine the type, severity and effect of transport constraints faced by farmers on farming related activities.

(d) discuss the farmers' efforts in overcoming transport constraints.

1.5 Research Hypotheses

The following hypotheses are tested in this study:

**HO1:** There is no significant difference in average trip lengths travelled daily by farmers in different locations of Mwea Tebere Irrigation Scheme.

**HO2:** There is no significant difference in average distances travelled between the homestead and the farm by farmers in Mwea Tebere Irrigation Scheme.

**HO3:** There is no significant difference in average time spent on farming related movement in different locations in Mwea Tebere Irrigation Scheme.

**HO4:** There is no significant difference in average time spent by men and women on farming related movement in different locations of Mwea Tebere Irrigation Scheme.

**HO5:** There is no significant difference in the means of transport used by men and women.

**HO6:** There is no discernible pattern in the rating of transport constraints experienced by farmers in Mwea Tebere Irrigation Scheme.
1.6 Justification for the Study

Transport at the farm level plays an important role in agricultural development and the economy at large. The national and international distribution of crop produce requires the initial collection of the produce from the farm to a central place, mainly the local market (Musyoki, 1986; Wambugu, 1989). Sources of farm inputs are usually located at the local markets that are at some distance from the farm. Inputs must therefore be moved from such local markets to the farm where the farmer utilises them. Haulage of farm inputs from regional, national and international sources to the local markets and the transport of farm outputs from local markets to other destinations is usually by motor vehicles and on all-weather roads. Whereas the provision of this transport is very important to a country, the transport activities between the local markets and the farm form a significant part of this trade. In spite of this important element, transport planners and policy makers have in the past decades neglected planning for transport at the local level and devoted most efforts to regional, national and international transport (Kaira, 1983; Khayesi, 1990, 1993; Tichagwa, 2000). This study examines the burden of short-distance travel on- and off-farm and discusses the implication for planning for this level of transport as it affects farming. The recommendations given on improving farming related transport are meant to make policy makers realise the need to give this part of transport system the attention it deserves.
Poverty is a major concern for nations worldwide. One of Kenya's national development objectives is eradication of poverty and improvement of the welfare of her citizens (Kenya, 1986a, 1998, 1999b). About 80% of Kenya's population is rural-based and majority of them are peasant farmers living in areas with poorly developed transport services. Although transport is one of the ways through which rural poverty could be reduced (Ogendi, 1992; Nalo, 1994; Howe, 1996, 1998), rural transport is still seen as a "step child" of infrastructure provision in Third World Countries (Metschies, 1998). Given this worrying state of affairs, this study seeks an in-depth understanding of rural transport situation and based on its findings recommends that the rural road network and the means of transport plying these roads, particularly non-motorised ones be improved. This recommendation, in addition to those that have been suggested in other rural transport studies will guide the development of an efficient and effective rural transport system in Kenya if implemented.

This study fills a gap in knowledge by linking transport geography and agriculture geography. According to the author's knowledge, transport and agriculture geographical studies have not given the interrelation of these two disciplines any special attention (for example, Mbwesa, 1988; Aduwo, 1989; Khayesi, 1990, 1993). This is one of the objectives of this study.
1.7 Scope and Limitations of the Study

This study is focused on farming related transport needs and provision in Mwea Tebere Irrigation Scheme. The analysis is limited to transport activities between the farm and the house and the market. The study concentrates on describing and discussing the basic transport features at the farm level and the transport constraints within which farming related movement takes place. It therefore, leaves out the transport logistics beyond the local market centres.

The current study covers only those farmers within Mwea Tebere Irrigation Scheme. Transport issues are examined with respect to five types of crops: rice, maize, beans, French beans and tomatoes. Rice is the dominant crop grown in the Scheme, maize and beans are the main staple crops and French beans and tomatoes are the most recently introduced horticultural crops for commercial purposes. Other crops such as green grams and kales are not included because they are produced in small quantities compared to the five crops in the scheme.

1.8 Definition of Key Concepts and Terms

The key terms and concepts used in this study are defined below:

Transport is the movement of people and goods through the modes of road, railway, waterways, footpaths and airways.
Transport demand is the amount of service which an individual, a group or an organisation is prepared to buy at a given price (Hay, 1973). The focus in this study is on transport demand of farmers.

Household refers to a people who live within the same compound fenced or unfenced and share meals, have a common source of income and provisions for other essentials of general livelihood.

Means of transport are the media that move on the modes and facilitate movement. They include walking, carts, donkeys, oxen, vehicles, trains, ships and aeroplanes (Khayesi, 1999).

Intermediate means of transport are media that facilitate movement and fall in between walking and use of motorised vehicles. They include hand- and animal-drawn carts, animal pack, bicycles, wheelbarrows and sledges (Riverson and Carapetis, 1991).

Accessibility refers to the ease with which a place can be reached. It can be evaluated by considering distance, road density, availability of a route, a vehicle to a place and nature of route (whether muddy and impassable, or gravel and passable) (Riverson and Carapetis, 1991; Ogendi, 1992). In this study accessibility is taken as the shortest distance in kilometres from a given farm to the market and/or the house.

Mobility refers to the ability of people and goods to move (Barwell, et al., 1988 cited in Riverson and Carapetis, 1991). In this study, mobility is assessed using such variables as distance covered, travel time, means and routes used.
Matatu refers to a small-scale public vehicle in Kenya. The term is derived from the Kikuyu term “mang’otore matatu”, which means thirty cents the then standard charges for fare by these vehicle operators when they were licensed to operate (Aduwo, 1989).

Farming related movement refers to trips made with an objective of accomplishing a given farming activity. Such trips include those to the market to buy farm inputs or sell outputs; to the river to pump water for irrigation; to the farm to cultivate, plant, apply fertilisers and pesticides, harvest, supervise labour; and to meetings aimed at discussing farm development.

Mau mau refers to an uprising by Kenyans, particularly the central highland people against colonialists as a result of land alienation (Kanogo, 1987).

Wakulima is a Kiswahili word for farmers. In this study Wakulima market refers to the largest market place in Nairobi where rural farmers sell their products.

1.9 The Study Area

1.9.1 Location

Mwea Tebere Irrigation Scheme is located approximately 100 kilometres North-east of Nairobi at the foothill of Mount Kenya. This scheme lies at an altitude of 1,159 metres above sea level. It is situated between latitudes 0°30’ and 0°45’
south and longitudes $37^\circ 14'$ and $37^\circ 30'$ east (Fig.1.1). It is located just above the confluence of rivers Nyamindi, Murubara and Thiba in Kirinyaga District. The irrigation water for the scheme is tapped from these rivers, which have a large water discharge (Chambers and Moris, 1973). Ecologically, Mwea Tebere Irrigation Scheme lies in the transition zone between the high potential upland and the drier marginal zones (Chambers and Moris, 1973; Shavagah, 1998).

1.9.2 A Brief History of Mwea Tebere Irrigation Scheme

The establishment of Mwea Tebere Irrigation Scheme started during the colonial period. Experiments on rice growing in the Tana River Basin were carried out in 1948 by the colonial government. The aim of these early experiments was to reclaim land and consequently, increase agricultural production. As a result, Mwea Development and Reclamation Scheme was established (Chambers and Moris, 1973).

In 1951, the African Land Development Organisation (ALDEV) survey revealed that 3,000-6,000 acres of land were indeed suitable for irrigation (Chambers and Moris, 1973). In 1952, a state of emergency was declared in Kenya and a detention camp was set up at Mwea. The detained people were used to provide labour for canal digging and construction of infrastructure, leading to the reclamation of the scheme (Chambers and Moris, 1973; National Irrigation Board, 1993).
Fig. 1.1: Location of Mwea Tebere Irrigation Scheme

Source: National Irrigation Board (1993)
In 1954, ALDEV sought to bring 40,000 acres under irrigation and settle between 10,000 and 12,000 farmers (Chambers and Moris, 1973). The selection of tenants was mainly based on landlessness. The landless were defined as those people who owned no land or had lost their land to the colonialists through alienation. During this period, growing of rice was attempted on both the black cotton and red soils. Red soils presented problems due to a high degree of percolation and were declared unsuitable for flood irrigation farming.

In 1956 and 1957, the Tebere headwork on the Nyamindi river and Thiba river headwork were completed, respectively. With an external donation from the United Kingdom Freedom from Hunger Committee, further development of 2000 acres was completed in 1967. In the same year, West Germany Kreditanstalt for Wiederaufbau (KFW) provided a loan for further extension of 3,000 acres, and for the construction of headquarters at Wang’uru (National Irrigation Board Annual Report, 1972-1973; National Irrigation Board, 1993).

From the 1960s onwards, the scheme grew from strength to strength. In 1966 the National Irrigation Board was established as a statutory body by the Act of the Parliament. The Board is administratively responsible for all irrigation schemes in Kenya.
1.9.3 Physical Environment

1.9.3.1 Climate

Mwea Tebere Irrigation Scheme is situated far enough from Mt. Kenya to escape much of its cloud cover during the day. This facilitates rapid crop maturation and sun-drying of rice. The Scheme is situated within a zone that receives substantial precipitation during the rainy seasons. The Scheme receives an average annual rainfall of 950 mm per year. The rainfall regime is bimodal, with long rains occurring in April and May and short rains in October and November (Chambers and Moris, 1973). The rainfall is adequate to support rain-fed agriculture. In fact, rainfall supplies most of the water required for plant growth on the Scheme, leaving the irrigation system to supply the balance for initial flooding of fields and constant renewing of water in the earlier stages of plant growth.

The Scheme experiences an average maximum temperature of 16°C in the cooler months of June to August and 26.6°C in hot months of December to February (Chambers and Moris, 1973). The planting of crops, especially rice, in the Scheme is carried out during the short rain season when temperatures are more than 17°C. These conditions favour rice production only once in a crop-year.
1.9.3.2 Soils

Soils in Mwea Tebere Irrigation Scheme consist of lateritic clay loam (red soils) and impermeable montmorillonitic clays, with about 80% clay or black cotton soils (Chambers and Moris, 1973; Shagavah, 1998). The origin of soils in Mwea Tebere Irrigation Scheme can be traced to volcanic eruptions that led to the formation of Mt. Kenya. The impact of the last eruption of Mt. Kenya on the hydrology of the upper Tana basin including Sagana, Thiba and Nyamindi rivers was a vast Pleistocene lake. The relatively flat surface left by Thiba basalt inhibited both the water drainage and its accompanying erosion. This led to a characteristic accumulation of lake sediments and the formation of extensive areas of black cotton soils. Rice cultivation is done on the black cotton soils and the other crops including maize, French beans and tomatoes are mainly grown on red soils.

1.9.3.3 Topography

The overall topography at Mwea Tebere Irrigation Scheme is uniform with relatively flat gradients of 0.3% (calculated by author from Topographical Map of 1975). This has enabled the management of the Scheme to adhere to standardized systems for field units and water control. As a result, the Scheme has undergone relatively cheap and orderly expansion. Also, due to this almost flat topography, irrigation is by gravity through a canal system.
1.9.4 Human Environment

1.9.4.1 Settlement and Population

The area where Mwea Tebere Irrigation Scheme is established used to be a mosquito-ridden swamp. Before its inception in 1954, the area was sparsely populated. It started as a detention camp for *Mau Mau* detainees but was later reclaimed. The government decided to settle people who were landless and unemployed in the reclaimed region of Mwea Tebere. The landless were recruited from Nyandarua, Nyeri, Muranga, Kiambu, Embu and Kirinyaga Districts. These districts had been faced by the problem of land alienation by the colonialists. As a result, majority of the people in these districts were either "Ahoi" (landless) or confined to villages or owned a land parcel of less than two acres (Chambers and Moris, 1973).

Since the 1960s, the Government of Kenya has expanded the areal coverage of the Scheme through extensions. More farmers have been settled as a result. The number of families settled in the Scheme is about 3,312 (Shagavah, 1998).

1.9.4.2 Crop Production

Rice farming is the main economic activity in Mwea Tebere Irrigation Scheme. The Scheme covers an area of about 12,140 hectares, out of which, 6,000
hectares are under rice. The rest is utilised for homesteads, schools, dispensaries, business premises, church plots and roads. Each tenant in the Scheme is allocated 1.6 ha (4 acres) of paddy field in 4 plots of 0.4 ha (1 acre each). Two rice varieties are produced in the Scheme: Basmati/Pishori and Sindano. These varieties have varied crop yields with Sindano and Basmati yielding 80 and 52 bags per hectare, respectively. In 1997/98, the average paddy production in the Scheme was about 21,000 tonnes (Kenya, 1999a). The average earning from paddy per farmer in the 1997/98 crop yield was estimated at Kshs. 72,285 (Shavagah, 1998). Apart from rice production, other crops such as onions, maize, beans, kales, tomatoes and French beans are grown.

Farming in the Scheme has contributed to the growth of businesses such as welding, grain milling, retailing, wholesaling, hotels, butcheries and banking. Thus, the Scheme provides livelihood directly or indirectly to an estimated 60,000 people (Shavagah, 1998).

Farmers live in 36 villages in the Scheme. Each village is located as centrally as possible in relation to the farm plots. There are at least a hotel, a butchery and a shop in each village.
1.9.4.3 Transport

Mwea Tebere Irrigation Scheme is served by roads and railway line. In fact, the all-weather Embu-Nairobi road passes through the Scheme (Fig.1.1). The Scheme is also served by feeder routes, which link its interior parts to the main roads. The feeder roads are earth and gravel surfaced. Both motorised and non-motorised means of transport ply these routes. Bicycles, donkeys, oxen, animal-drawn carts, *matatus*, lorries and pick-ups are commonly used in the scheme. These means of transport in the Scheme are very important for daily travel and transport activities. They are also very significant for the development of the Scheme as it is through them that haulage of farm inputs and outputs takes place.

1.10 Rationale for the Choice of the Study Area

The high rice production in Mwea Tebere Irrigation Scheme has been attributed to, among other factors, its location in close proximity to the all-weather Embu-Nairobi road and the railway station at Sagana (Chamber and Moris, 1973). These modes of transport facilitate the haulage of rice from the Scheme to the local and regional markets. With such transport arrangement, it is possible to ignore the transport needs of the farmer which cannot be fully addressed by the presence of “car and road” as pointed out by Kaira (1983), Khayesi (1993) and
Howe (1996). It is against this background that Mwea Tebere Irrigation Scheme is selected as the study area.

Mwea Tebere Irrigation Scheme is the largest irrigation scheme in Kenya. Unlike the other large-scale irrigation schemes in the country such as Hola, Bura, Ahero, Perkerra and Bunyala, Mwea Tebere Irrigation Scheme has been reported as successful in cash flows (Shavagah, 1998). In addition, the activities taking place in Mwea Tebere Irrigation Scheme do affect the operations of other rice growing schemes. Kyendo (1999) reported that the refusal by farmers in Mwea Tebere Irrigation Scheme to market their rice through the National Irrigation Board led to the closure of Ahero and Bura. This could partly explain why a number of studies (Tsuruuchi and Waiyaki, 1995; Ruigu, 1988; Chambers and Moris, 1973) have been conducted in Mwea Tebere Irrigation Scheme. Tsuruuchi and Waiyaki (1995), for example, conducted a comparative economic survey between the farmers within the scheme and those at the scheme’s outskirts. It is therefore supposed that the recommendations from the current study on Mwea Tebere Irrigation Scheme can be extended to improve the farm level transport situation to farmers in other irrigation schemes.
CHAPTER 2
REVIEW OF LITERATURE

2.1 Introduction

This chapter presents a review of literature and a discussion of the theoretical framework. A review of literature is discussed under three sub-themes: rural transport needs and travel characteristics, rural transport constraints and rural transport planning. On the basis of the theoretical framework discussed, a conceptual model to guide the analysis is derived.

2.2 Rural Transport Needs and Travel Characteristics

There is a growing body of studies on rural transport (for example, Chiteji, 1980; Kaira, 1983; Khayesi, 1990, 1993, 1995; Barwell, 1996; Odero, 1997). However, it should be noted that these studies have not given special attention to the theme of farming related transport needs and provision. Studies on rural transport are basically concerned with analysis of trip purposes, lengths, modes and means of transport at household level. Although these studies have some discussion on agricultural transport, this is not their main theme of investigation. These studies are significant in that they have laid a foundation upon which a study such as the current one can be built on.
Rural households are involved daily in a variety of trips with diverse purposes. The studies that have examined trip purposes have shown that rural dwellers are involved in trips aimed at acquisition of needs such as food, water, employment, education, energy and health care (Table 2.1). It is evident from these studies that farming is an important activity in rural households. Khayesi (1990, 1993), for example, found out that majority of the respondents (51.7%) were involved in farming-related movement. The importance of farming related movement to rural households in Kenya warrants some special attention. Whereas this is true, the dynamics of farming related movement, especially farm level transport have not received much attention from researchers. What exists is an analysis of farming movement as part of other themes.

Table 2.1: Trip Purposes

<table>
<thead>
<tr>
<th>Author</th>
<th>Theme</th>
<th>Spatial Unit</th>
<th>Trip Purposes</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chiteji (1980)</td>
<td>An investigation of transportation needs of the rural population</td>
<td>Uluguru and Morogoro, Tanzania</td>
<td>Farm, market</td>
<td></td>
</tr>
<tr>
<td>Kaira (1983)</td>
<td>An investigation of transportation needs of the rural population in developing countries</td>
<td>Two villages in Kirinyaga District, Kenya</td>
<td>Farm, river, leisure, shopping</td>
<td>None of these studies gives special attention to the analysis of the farming related movement</td>
</tr>
<tr>
<td>Khayesi (1990, 1993)</td>
<td>An analysis of road network pattern and household travel characteristics</td>
<td>Kakamega District, Kenya</td>
<td>School, farm, work, domestic, religious, administrative</td>
<td></td>
</tr>
<tr>
<td>Ogendi (1992)</td>
<td>Accessibility and transportation problems of small-scale farmers</td>
<td>Kakamega District, Kenya</td>
<td>Farm, work</td>
<td></td>
</tr>
</tbody>
</table>

Source: Compiled by author
Studies reveal that rip length of rural travel, a measure of the spatial extent of movement, falls within 10 kms in rural areas (Table 2.2). This trend has been explained in the light of the rural economy and location of facilities in rural areas (Khayesi, 1990). Agriculture is the main activity of the rural population. Besides farming, rural people are also involved in small-scale businesses. Farms are mainly located within the village while businesses are located in the local urban and market centres serving such villages. The farms and local market centres are usually within the distances that can be covered on foot.

Table 2.2: Travel Range

<table>
<thead>
<tr>
<th>Author</th>
<th>Spatial Unit</th>
<th>Distance covered in Travel</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chiteji (1980)</td>
<td>Uluguru and Morogoro, Tanzania</td>
<td>87.5% of the trips made cover up to 3.2 kms</td>
<td>Whereas all these studies are relevant to rural areas dependent solely on rainfed agriculture and farmers are free to grow the crops of their choice, the current study is relevant to a rural setting relying on irrigation and at least growing rice among other crops.</td>
</tr>
<tr>
<td>Kaira (1983)</td>
<td>Two villages in Kirinyaga District, Kenya</td>
<td>80% of the trips are up to 7 kms</td>
<td></td>
</tr>
<tr>
<td>Khayesi (1990, 1993)</td>
<td>Kakamega District, Kenya</td>
<td>90% of the trips made are up to 8 kms</td>
<td></td>
</tr>
<tr>
<td>Ogendi (1992)</td>
<td>Kakamega District, Kenya</td>
<td>-70% of off-farm trips cover less than 9 kms -average on-farm trip distances are 1.5 kms</td>
<td></td>
</tr>
<tr>
<td>Riverson and Carapetis (1991)</td>
<td>Sub Saharan Africa</td>
<td>Average distances between field and village are 3.5 kms</td>
<td></td>
</tr>
</tbody>
</table>

Source: Compiled by author

Trips are covered on certain routes or modes. Studies that have examined this element reveal that various routes (footpaths, tracks, gravel surfaced roads, paved roads and railway lines) are used in rural areas (Chiteji, 1980; Kaira, 1983; Khayesi, 1990, 1993, 1995; Riverson and Carapetis, 1991; Barwell, 1996). Khayesi (1990) found
out that in Kakamega District, short distance trips took place on footpaths and tracks. These trips involved activities such as farming that often took place within the same village. Kaira (1983) found out that 72% and 10% of the cash crops grown in Kirinyaga District were transported by animal-cart and backloading, respectively, along footpaths rather than tarmac roads. Thus, footpaths and tracks are important links within and between villages. The current study is undertaken against such a background with an aim of establishing whether footpaths and trucks are important in the study area whose success in farming has been attributed to its close proximity to tarmac roads and a railway connection.

Both motorised and non-motorised means of transport are used in rural areas to meet different transport needs (Table 2.3). Non-motorised means of transport (walking/human porterage, bicycle, animal- and hand-driven carts) play an important role in rural transport. This has been explained in the light of distances covered, amount of goods transported and the nature of routes used. Khayesi (1990), for example, established that about 67.7% of trip lengths less than 8 kms were undertaken using bicycle, motorcycle, hand-driven carts and walking. The use of these non-motorised means of transport, however, declined as distances increased to give way to motor vehicles. Sieber (1997) found out that farmers who used donkeys and/or bicycles cultivated bigger fields and used more fertilizers. While households that used donkeys marketed twice than those ones that had no intermediate means of transport, those who used bicycles marketed two fifths compared to those without intermediate means of transport. It should be noted that each local (rural) area has different transport needs and
consequently, demand for various means of transport. The current study clearly identifies the transport needs of farmers in Mwea Tebere Irrigation Scheme so that suitable interventions can be made.

Table 2.3: Means of Transport

<table>
<thead>
<tr>
<th>Author</th>
<th>Spatial Unit</th>
<th>Means of Transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chiteji (1980)</td>
<td>Uluguru and Morogoro, Tanzania</td>
<td>The bicycle dominated the trips, followed by walking, buses and lorries</td>
</tr>
<tr>
<td>Kaira (1983)</td>
<td>Kirinyaga District, Kenya</td>
<td>Walking dominated shopping and leisure trips followed by the bicycle and matatus in one of the two villages. In the other village the bicycle predominated. Animal-drawn carts dominated the trips involving transport of farm produce (cotton, maize, beans). It was followed by matatus and walking in that order. In transport of milk, walking dominated followed by the bicycle.</td>
</tr>
<tr>
<td>Khayesi (1990, 1993)</td>
<td>Kakamega District, Kenya</td>
<td>Walking dominated all the trips followed by motor vehicles, bicycle and hand-driven means</td>
</tr>
<tr>
<td>Ogendi (1992)</td>
<td>Kakamega District, Kenya</td>
<td>Human porterage dominated the transport of farm produce. It was followed by bicycle, hand-drawn carts, trucks and pick-ups</td>
</tr>
<tr>
<td>Barwell (1996)</td>
<td>Kaya and Dedougou, Burkina Faso; Kasama and Lusaka, Zambia; Mbaie, Uganda</td>
<td>Walking dominated household travel and transport. It was followed by bicycle, wheelbarrows, hand-carts, sledges, pick-ups, tractors and lorries in that order.</td>
</tr>
<tr>
<td>Sieber (1997)</td>
<td>Makete District, Tanzania</td>
<td>Walking, cycling and donkey-carts were the main means of transport used</td>
</tr>
</tbody>
</table>

Source: Compiled by author

The foregoing discussion reveals that short-distance rural household transport activities rarely involve motor vehicles but rely heavily on non-motorised means of transport. This creates a need for time- and energy-consuming movements of loads and personal travel over relatively short distances (Tichagwa, 2000). In an attempt to determine the use of public transport service availability in the two villages of Kirinyaga District,
Kaira (1983) examined the time spent by the roadside by individuals waiting for a bus or a matatu. He found out that the average time in one of the villages (farthest household located 5 kms from tarmac road) was between 15 and 30 minutes. For the other village (nearest household to the tarmac road located 6 kms), the average waiting time was between 60 and 120 minutes. He concluded that the first village was better served and thus more accessible than the second. The differences in waiting time were explained with respect to variation in the number of matatus plying the two villages during market days. During such days, average waiting time could go as low as 5 minutes for the accessible village and 15 minutes for the less accessible village. The current study builds on the aspect of time by analyzing the time spent in farming related movement by farmers in Mwea Tebere Irrigation Scheme.

Other studies (for example, Barwell, 1996; Sieber, 1997) that have examined the time aspect have established that various household activities must be distributed within the time available to a household. Consequently, time spent on different activities becomes very important. Domestic activities often take the largest proportion of the time available to a household. Barwell (1996) found out that the average time spent daily by an adult in Kaya, Dedougou, Kasama, Lusaka and Mbale villages on all travel and transport activities ranges from 0.8 to 2.5 hours. Seventy five per cent of this time is spent on domestic-related activities, 18% on agricultural-related activities and 7% is shared between health and market-related activities. Sieber (1997) found out that a lot of time and effort was spent to secure the household's subsistence needs other than in providing labour in agricultural fields in Makete District, Tanzania. This significantly
hampered the growth of per annum agricultural production. Given that agriculture is an important activity for rural households and that 70% of agricultural activities involve transport (Kaira, 1983), the current study analyses the time spent in farming related movements.

2.3 Rural Transport Constraints

A number of transport constraints are well documented and analyzed in rural transport studies (Table 2.4). These constraints have negative environmental, social and economic impacts. With respect to agriculture, poor road transport has been responsible for a low degree of reliable farm-to-market access (Porter, 1998). Chiteji (1980) found out that due to lack of adequate transport, farm produce such as beans in Morogoro region in Tanzania rot on the farm. Fertilizers could not get to Morogoro from the local markets until after the growing seasons were almost over. Ogendi (1992) found out that whereas transport facilities for major cash crops such as tea and sugarcane in Kakamega District were available, those for minor food crops such as potatoes, sorghum, maize, millet and vegetables were virtually non-existent. Hence, many small-scale farmers depended on middlemen who offered transport services even though these traders often bought their crops at a low price. The current study has gone beyond identifying the transport constraints and established the farmers’ assessment of the severity and effects of these constraints on farming in Mwea Tebere Irrigation Scheme.
Table 2.4: Transport Constraints

<table>
<thead>
<tr>
<th>Author</th>
<th>Spatial Unit</th>
<th>Constraints</th>
</tr>
</thead>
</table>
| Kamulali (1977) | Bukoba District, Tanzania    | • Dusty and muddy tracks  
• Reliance on human porterage  
• Low road density and poor connectivity  
• Severe potholes  
• Poorly aligned road network  
• Low vehicle fleet |
| Chiteji (1980) | Uluguru and Morogoro, Tanzania | • Dusty and muddy roads  
• High transport cost  
• Poor state of modes of transport,  
• Inadequate transport services  
• Poor state of modes of transport |
| Kaira (1983)  | Kirinyaga District, Kenya    | • Reliance on human porterage  
• Low ownership of means of transport  
• Inaccessibility to available means of transport |
| Khayesi (1990, 1993) | Kakamega District, Kenya     | • Uneven distribution of road network  
• Reliance on human porterage  
• Bush overgrown footpaths  
• Potholed roads  
• Worn out road ends  
• Muddy roads |
| Ogendi (1992) | Kakamega District, Kenya     | • Worn out roads  
• Washed away bridges  
• Potholed roads  
• Low vehicle ownership  
• Inadequate means of transport |
| Nalo (1994)   | Kenya                        | • Reliance on human porterage  
• Unreliable and expensive motorised transport  
• Poor road maintenance |

Source: Compiled by author

Provision of transport services to rural dwellers has been given little attention in studies related to rural transport. Although Ellis and Hine (1998) address this issue, their focus is mainly on transport services beyond the local markets. The provision of affordable and efficient rural transport services to rural dwellers is, however, constrained by many factors. These factors include "the poor conditions of rural roads, the high cost of vehicles, restrictions on their supply, the non availability of spare parts, inadequate maintenance capacity and capability and the loss-making nature of public transport"
services” (Fernando, 1999:3). Even where rural transport services are readily available, their success in meeting transport needs for various people varies (Kaira, 1983; Overton, 1996; Iga, 1999). Iga (1999) found out that more men than women used the boda boda taxi services in Uganda. The reasons for the variation in usage of boda boda were that: “only a few women could afford to pay for the services, women feared harassment from undisciplined operators, the awkward sitting positions and cultural taboos such as body contacts with male operators by holding them around their waists during the journey” (Iga, 1999:13). Hence, the need to examine on the provision of affordable and efficient transport services to people at the farm level, who would otherwise have to accomplish all their travel mainly on foot.

2.4 Rural Transport Planning

Rural transport depends mainly on foot, animals, bicycles and other non-motorised means on roads, tracks and footpaths (Kaira, 1983; Khayesi, 1990, 1993; Ogendi, 1992; Tichagwa, 2000). In order to improve rural transport, policy makers and planners need to focus on improving both the routes and means of transport in rural areas. This was, however, not the case in many third world countries until 1980s (Kaira, 1983; Ellis and Hine, 1998; Fernando, 1999; Caraballo and Anguizola, 1999).

Before 1980s, rural transport planners followed the road-car transportation approach (Howe, 1996). This approach placed greater emphasis on speed than access, improving and rehabilitating main roads to ensure shorter travelling times. Kaumbotho (1999), for
example, found out that once the Government of Kenya tarmacked the Thuci-Nkubu road in Meru District, it halted all support to the smaller rural access roads and left it to local initiative. The consequence has been the collapse of Nkone Bridge that linked the community living at Karia hilltop location to the outside world. This has led to the isolation of the community. Tichagwa (2000) in a discussion on the issue of trunk and feeder roads construction observes that these roads are “mismatched with travel and transport needs within and around the homestead which account for 80% of the total transport burden” (Tichagwa, 2000:10). Rural dwellers use trunk and feeder roads occasionally for visits to hospitals, securing agricultural inputs and marketing of produce. Whereas it is important to have well maintained main roads, it is also necessary to ensure that there is accessibility for all in rural areas.

Kaira (1983), while addressing the problem of the inability of the road-car transportation planning approach in solving the rural transportation problems analyzed the transportation needs of the rural population in Kirinyaga District, Kenya. He aimed at providing a strong basis for a bottom-up approach, which begins with local systems and needs as the basis for continuous planning process. He pointed out that the bottom-up approach begins with an understanding of the transport situation of the rural people. It should, however, be noted that the bottom-up approach cannot be generalized for every rural area as every region has unique transport characteristics. There is therefore need to understand as much as possible the specific transport characteristics of various rural areas. The current study examines the travel characteristics at the farm level with an aim to make practical recommendations to address transport needs in the study area.
Rural transport studies, for example, Kaira (1983), Ogendi (1992) and Kipke (1996) reveal that travel patterns and transport needs of rural populations are shaped by subsistence agriculture which rarely warrants use of motor vehicles. Hence, the need to promote intermediate means of transport that are more suited to address such problems. Kipke (1996), for example, points out that cycling is up to 12 times more efficient than walking. Also, a number of transport studies conducted in rural areas reveal that the transport burden on women is substantial and the motor vehicle oriented transport planning approach is inflexible in addressing women’s transport needs (Salifu, 1995; Okeaduh, 1995; Overton, 1996; Barwell, 1996; Calvo, 1997,1994a,b; Kipke and Fernando, 1998; Tichagwa, 2000).

Adequate, reliable and economical means of transport is a prerequisite for overall rural development (Kenya, 1997a). Given this fact, the Government of Kenya and major international aid agencies have invested a lot in transport. In doing so, a lot of effort has been directed to motorable roads, conventional motor vehicles and export agricultural produce (Kaira, 1983; Karuiru, 1996; Kenya, 1997c). The effectiveness of conventional rural transport planning approach practiced in the rural areas of developing countries has been questioned in a number of empirical studies (Kaira, 1983; Nalo, 1994; Howe, 1998; Sieber, 1998,1997; Sieber and Kipke, 1998; Ahmed, 1999). The road-car transportation approach has neglected the majority poor who cannot afford motor vehicles.
The government of Kenya has attempted to improve agricultural production through improving accessibility in rural areas. With respect to this, the government has initiated programmes such as Rural Access Road Programme (RARP), Minor Roads Programme (MRP), Special Roads and Roads 2000 (Karuiru, 1996; Kenya, 1997a,c; Ministry of Agriculture, 1998). Through these programmes, the government has created some degree of local participation and involvement in the identification, planning and execution of rural road projects. Despite the government's efforts, rural areas are still experiencing transport constraints (Nalo, 1994). Kaira (1983) points out that the continued construction of feeder roads has been progressing with no reference or concern for the undeveloped traditional modes of transport that are used by more than 90% of the rural population. Hence, the need to engage the rural population in transport development discourse in order to lay down an appropriate design of the road infrastructure and the means of transport operated on these roads. The current study investigates the transport needs at the farm level and thus adds to the knowledge available on rural transport to planners.

Improvements of rural transport in developing countries have lowered the costs of agricultural production directly (World Bank, 1996). This is as a result of increasing access to markets, credits and indirectly by facilitating the development of the non-agricultural rural economy. Transport improvement should be capable of acting as an instrument of poverty reduction. However, this does not always happen because the poor incur high costs in terms of time and money in transporting outputs to markets, acquiring goods and gaining access to employment, health services, education and other
amenities. The World Bank (1996) points out that transport policy can be focused to give particular assistance to the poorest groups. This can be either directly through concentration on the needs of particular social groups such as poor workers and women or indirectly through assistance to those modes of transport on which the poor are known to be particularly dependent. To effectively address the transport constraints of particular social groups, there is need to utilize data collected from these groups.

2.5 Theoretical Framework

A discussion of the theoretical issues, spatial interaction and transport component in agricultural land use location theory, relevant to this study is presented in this section. Based on the theoretical issues discussed, a conceptual model guiding the study is then derived and presented.

2.5.1 Bases of Spatial Interaction

The basic determinants of spatial interaction and therefore movement of people and goods have been summarised in a four-factor typology namely, complementarity, utility, intervening opportunities and transferability (Ullman, 1974; Lowe and Moryadas, 1975). The core argument with respect to complementarity is that in order to have movement between two areas, there must be demand in one and supply in the other. Both demand and supply must be specifically complementary. Specific complementarity refers to the existence of a surplus of a given commodity or service in
a given area and demand in another. For example, the surplus of crops (rice, tomatoes, French beans, maize, beans and green grams) produced in Mwea Tebere Irrigation Scheme must be transported from their point of production to an area of deficit (locally, nationally or even internationally). A case at hand is rice production where about 80% of the rice consumed in Kenya comes from Mwea Tebere Irrigation Scheme. This implies that the accessibility of Mwea Tebere Irrigation Scheme by other parts of the country is essential for rice distribution to take place. Complementarity is therefore an important factor in an interaction system.

It should, however, be noted that mere complementarity will not automatically result in movement. Ullman (1974) argued that complementarity generates exchange between two areas only in the absence of intervening opportunities. Intervening opportunities arise when an alternative, closer and more accessible source of supply of the required goods and services exists. This leads to substitution of areas. For example, the crops produced in the study area are also produced in other regions in Kenya. Thus, the supply of tomatoes to the residents of Nairobi may not necessarily be from Mwea Tebere Irrigation Scheme but from Kiambu District, which is closer to Nairobi.

Ullman (1974) further observed that if the distance between source and destination is too great and too costly to overcome, interaction would not take place in spite of perfect complementarity and absence of intervening opportunities. This leads to substitution of goods. Also, a good that is involved in interaction between two places must be capable of being transferred. Different goods have different degrees of transferability measured
in real cost of transfer. Transfer cost includes all costs associated with movement such as the price of transportation, insurance in transit, storage charges, pick-up and delivery charges as well as time spent in transport (White, 1976; Ellis and Hine, 1998).

Another factor responsible for spatial interaction is utility (Lowe and Moryadas, 1975). Utility is the capacity of a commodity or a service to satisfy human want. Lowe and Moryadas (1975) identified two types of utility: place and time. Place utility is the added economic value of a commodity created by transporting it from a place or an area in which it has little or no usefulness or value to a place or places in which it has greater usefulness or value. Time utility is achieved through transportation, which enhances the ability of goods to satisfy human wants by making goods available not only where they are needed but also when they are needed. For example, the horticultural crops (tomatoes and French beans) produced in Mwea Tebere Irrigation Scheme are highly perishable. These crops are mainly marketed in towns that are located far from the farms. Hence the need for fast transportation for these crops to reach the market while still fresh.

The four-factor typology of spatial interaction provides a useful framework for analysis of movement. These factors have been elaborated in a number of transport studies such as Ogonda (1986) and Seeth, Chachnov and Surinov (1998). They have partly been used to derive the conceptual model for this study.
2.5.2 Transport Component in Agricultural Land Use Location Theory

Agricultural activities are space-consuming or area-occupying. Lowe and Moryadas (1975) point out that it is possible to conceive of the specific use of a parcel of land as being a function of its distance from the market. This is the problem von Thünen (1826) addressed in his work, the Isolated State. In his analysis of the emergence of land use pattern, von Thünen identified transport elements to be among factors that significantly influenced the land use pattern. These transport elements are: distance from the parcel of land to the market, means of transport used (horse-drawn wagon), nature of mode used, and transportation cost. von Thünen demonstrated that (Knox and Agnew, 1989):

(i) each land use occupies an area for which its marginal revenue is greater than that of its transportation cost.

(ii) as distance increases from market, intensive agriculture plays a progressively small part in land use.

(iii) the spatial distribution of land uses depends on the comparative rent paying ability of different land uses.

(iv) concentric zones of land use develop around market centre.

von Thünen pointed out that transport is one of the key factors in decision-making on land use. He explained the relevant transport costs that determine the use to which different parcels can be put. Although he demonstrated long ago the importance of transport in agricultural activities, this aspect has not been followed consistently in subsequent agricultural studies. In Kenya, there is limited research on transport in
agriculture. There are a few studies on this aspect, for example Odero (1997) and Odhiambo (1998) but they are more concerned with costs and not the other salient as is the case in the present study. In the next section, a conceptual model relevant for analysis of farming related transport situation in Mwea Tebere Irrigation Scheme is presented.

2.6 A Conceptual Model of Farming Related Transport Demand and Supply

A model of farming related transport demand and supply requires an understanding of the travel pattern and transport needs of individual farmers. The farming related travel and transport needs are important aspects of the overall rural and household travel and transport needs. According to Kaira (1983), Khayesi (1990) and Tichagwa (2000), the travel pattern and transport needs of an individual in rural conditions are determined by:

(i) the location of essential facilities such as schools, clinics, market centres, shopping centres, water sources and plots of land in relation to dwelling place.

(ii) the nature and frequency of daily activities performed in the household as well as on-and-off the farm.

(iii) dynamics of rural and national economy.

A conceptual model showing the relationship between farming related transport needs and their satisfaction is presented in Fig. 2.1. This model has been used to guide the inquiry into farming related transport needs and provision in Mwea Tebere Irrigation
Demand for transport has been taken as the fundamental basis of explanation of farming related transport situation.

### Basic Factors in Farming Related Transport Needs (Transport Demand)

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Outputs</th>
<th>Origin and Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Land</td>
<td>• Agricultural produce</td>
<td>• Farm</td>
</tr>
<tr>
<td>• Labour</td>
<td></td>
<td>• House</td>
</tr>
<tr>
<td>• Water</td>
<td></td>
<td>• Market</td>
</tr>
<tr>
<td>• Fertilizer/manure</td>
<td></td>
<td>• Roadside</td>
</tr>
<tr>
<td>• Seeds</td>
<td></td>
<td>• Store</td>
</tr>
<tr>
<td>• Manure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Pesticides</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Satisfaction of Farming Related Transport Needs (Transport Supply)

<table>
<thead>
<tr>
<th>Means of transport</th>
<th>Routes</th>
<th>Supplier (Agent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Bicycle</td>
<td>• Footpath</td>
<td>• Government sector</td>
</tr>
<tr>
<td>• Walking</td>
<td>• Tarmac road</td>
<td>• Private sector</td>
</tr>
<tr>
<td>• Matatus</td>
<td>• Gravel road</td>
<td>• Individual farmer</td>
</tr>
<tr>
<td>• Buses</td>
<td>• Railway</td>
<td></td>
</tr>
<tr>
<td>• Trains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Animals</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Carts</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


Demand for transport refers to the amount of service which an individual, a group or an organisation is prepared to buy at a given price (Hay, 1973). Demand is largely due to spatial separation of activities, which create a supply in one area and a demand in another. This is essentially the factor of complementarity. This leads to initiation of movement to bridge the spatial gap (Hay, 1973). Agricultural movement arises out of the need to move inputs and outputs, to, from and within the farm. The inputs required
include land, labour, seeds, water, pesticides, insecticides and fertilizers. These inputs, apart from land, must be moved from sources to farm. The sources may be both on- and off- the farm. On-farm sources include moving inputs from one point of the farm to another. Off-farm sources include neighbouring farms, granaries, market centres and any other locality at some distance from the farm.

Outputs must be moved from the farm to the market, store and/or house. The destination of the output depends on whether the crops are produced for commercial or subsistence purposes, or both. Kaira (1983) pointed out that it is necessary for majority of subsistence farmers in developing countries to sell surplus farm products in order to get cash to buy consumer goods and to pay for special services. This is true of Mwea Tebere Irrigation Scheme where farming is the main economic activity. The surplus crop produce can be sold at the farm-gate, local market or at points along the road. Where the surplus cannot be sold at the farm-gate, a farmer must transport the surplus to the local markets or to points along the road where he/she can sell to itinerant traders or passers-by (Musyoki, 1986; Ogendi, 1992). The frequency and quality of consignments depend on the local market schedule of a crop and the demand for a particular product at local market or along road points.

Agricultural products are usually in varying amounts and are transported over varying distances, ending up at different destinations. Thus, farming related movement is influenced by the load type and size and is distributed among different points of origin and destinations. In reality, farming related movement involves criss-crossing, resulting
from the need to transport the produce to various destinations. Individual movements attracted to and generated from each farm combine to form flows of inputs and outputs for which specific characteristics, features and issues can be analysed: distances covered, amount of time spent, amount of goods transported, means of transport used, monetary costs incurred, agents involved and constraints experienced. In order to meet any transport demand, the supply of transport services is required.

The supply of transport services is dependent on the demand for transport, which is a function of the nature of the economy as well as planning for transport system in a region (Ellis and Hine, 1998). Transport networks (routes) and means of transport (both motorized and non-motorized) are necessary for transportation of farm inputs and outputs. The farmer requires different means of transport, to transport farm products such as livestock, poultry, dairy products, cash crops and subsistence crops. Transport demand for a number of farm activities arise at different places and times. Different agents have emerged to supply transport services in Mwea Tebere Irrigation Scheme. These include individual farmers, government organisations, private organisations and itinerant traders. These agents are attracted to offer the needed transport services depending on the existing arrangements between farmers and the National Irrigation Board, market forces and intensity of demand.

Efficient transportation accomplishes movement of goods and people with the least force and in the shortest time possible (Sieber, 1997). Efficiency of transport is concerned with overcoming the economic costs imposed by time and distance. By
overcoming the frictional effect of distance, transportation can extend demand and supply. Where inadequate or poor means of transport prevent the movement of goods, either to or from other places, the demand by people in such an area becomes limited to only what can readily be supplied to them. While on one hand, the prevailing transport demand in a given area initiates the need to supply transport service, on the other hand, the existence of efficient transport supply system influences demand to a certain extent. For example, where diverse means of transport are readily available and the routes relatively good, the economic cost imposed by time and distance is reduced. The farmer therefore enjoys a vast choice of transport services.
CHAPTER 3
RESEARCH METHODOLOGY

3.1 Introduction

This study has utilised mainly primary data collected from farmers in Mwea Tebere Irrigation Scheme. The methods used to collect and analyse data are described in the sections that follow.

3.2 Sampling Design

Mwea Tebere Irrigation Scheme is divided into five sections or sites, namely Mwea, Thiba, Tebere, Wamumu and Karaba. Three of these sections were purposely selected for data collection. These are Karaba, Thiba and Tebere. Tebere and Thiba were chosen because they are relatively closer to the Embu-Nairobi tarmac road compared to other sections. Karaba was selected because it lies furthest from the Embu-Nairobi tarmac road. This variation in proximity to Embu-Nairobi tarmac road was seen as an important variable in explaining some of the changes in farming related transport situation as distance increase from an all-weather and motorised road to non all-weather roads.

A sample of 82 households with 23, 27 and 32 households from Karaba, Tebere and Thiba, respectively, were then selected for this study. The households were purposely chosen depending on the presence of members in the homestead. The survey included any household member mature enough to be involved in one way or
another in farming activities. This was deemed significant in establishing the farming related travel characteristics. From these households a total of 108 respondents (42, 38 and 28 from Tebere, Thiba and Karaba, respectively) were selected.

3.3 Data Collection

The primary data for this research were collected between the months of May and October 1999. A variety of methods were employed in data collection for this study. A questionnaire-based survey, space-time movement frequency matrix and focus group discussions were used. Through these instruments, information on variables shown in Table 3.1 was collected. To ensure that these instruments could meet the objectives of the current study, the researcher conducted a pilot survey in December 1998. During the pilot survey, the questionnaire and the space-time movement frequency matrix were administered to fifteen household heads. This helped the researcher to make the unclear questions clear and therefore make the instruments reliable.

Table 3.1: Description of Research Variables

<table>
<thead>
<tr>
<th>Variable Specification</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>Kilometres</td>
</tr>
<tr>
<td>Time</td>
<td>Hours and minutes</td>
</tr>
<tr>
<td>Amount of agricultural produce</td>
<td>Kilograms</td>
</tr>
<tr>
<td>Means of transport used</td>
<td>Walking/human porterage</td>
</tr>
<tr>
<td></td>
<td>Bicycle</td>
</tr>
<tr>
<td></td>
<td>Animal-drawn carts</td>
</tr>
<tr>
<td></td>
<td>Motor vehicle</td>
</tr>
<tr>
<td>Routes used</td>
<td>Footpaths</td>
</tr>
<tr>
<td></td>
<td>Tracks</td>
</tr>
<tr>
<td></td>
<td>Gravel surfaced roads</td>
</tr>
<tr>
<td></td>
<td>Paved roads</td>
</tr>
<tr>
<td>Transport supplies/agents</td>
<td>Government sector</td>
</tr>
<tr>
<td></td>
<td>Private sector</td>
</tr>
<tr>
<td></td>
<td>Individual farmer</td>
</tr>
</tbody>
</table>

Source: Compiled by author
The researcher and an assistant collected the primary data. To enhance smooth collection of data, the researcher ensured that the assistant came from the study area. This was important in building a rapport with and confidence in the respondents.

First, a questionnaire comprising of closed and open-ended questions was used to collect data from farmers on the following aspects: distance between the farm plot and the farmer's residence, type of crops grown, average amount of crops harvested per season, provision of transport services, transport problems, their effects on farming and farmers’ response to these problems (Appendix 1). Questionnaires were presented to household heads and were administered by the researcher and the assistant. The interviewers asked the respondents the questions, probed him or her, clarified the questions where necessary and recorded all the responses.

Secondly, space-time movement frequency matrix was designed to specifically acquire information on a respondent’s daily movement over space. By use of this matrix, information on trip purpose, trip length (distance covered), trip origin and destination, time taken, types of goods carried and amount of load moved, means of transport used, agents providing transport services, transport cost and nature of routes used was elicited (Appendix 2). This instrument, just like the questionnaire was administered to the household heads and any other member of the household involved in farming and present at the time of the survey.

Thirdly, informal interviews were conducted to gain insights into farming related transport needs and satisfaction to complement data collected using the
questionnaire and the space-time movement frequency matrix. Informal interviews were limited to farmers and individuals involved in providing services to farmers on hire. The farmers selected for informal interviews included those who were not found too busy and could therefore provide some extra time for discussion after filling in the two research instruments already described. Transporters were selected around the market places during market days.

Fourthly, two focus group discussions were conducted to gain insight on some transport aspects, for example, transport constraints faced by farmers in the study area. One focus group discussion involved five farmers and two agricultural officers. The other focus group discussion included two animal-drawn cart transport operators and two farmers.

Photographs were taken for illustrations. This was done while collecting data in the field. Photographs are presented in the relevant parts of this thesis.

3.3.1 Problems Encountered in Data Collection

Three major problems were encountered while collecting data for this study. The first was that data were collected at a time when the Mwea Tebere Irrigation Scheme was experiencing a crisis regarding the marketing of rice. Since the inception of the Scheme, the National Irrigation Board had been handling the marketing of rice. The farmers were, however, not satisfied with the marketing services offered by the Board. Beginning 1998/99 crop year, farmers took over the marketing of rice
through the farmers’ multipurpose cooperative society (Kyendo, 1999; Munene and Waweru, 2000). The crisis made the respondents suspicious of any stranger. They thought that the researchers were government officials on duty, investigating into the then ongoing crisis. The respondents were thus unwilling to answer some questions. For example, a number of them were reluctant to discuss issues relating to destinations of rice crop after harvesting.

The second problem was that some respondents wanted to know what tangible benefits they would derive from the survey before answering the questions directed to them. To overcome the above two problems, time and effort were spent on explaining to every respondent that the research was purely academic and that his or her responses would be treated with confidentiality.

The third problem was related to finding the respondents at home. Most farmers leave their homes early in the morning for daily activities. The problem of not finding people at home was handled by going early in the morning to the respondents’ homesteads. This made it possible for a number of respondents to be found before they set out for the day. In cases where the respondent expressed willingness to be interviewed but was hurrying to some place an appointment for an interview was fixed.
3.4 Data Processing and Analysis

The data collected were edited to ensure that the entries and/or recordings were properly done. The data were then coded and a database prepared using the Statistical Package for Social Science (SPSS) version 6.3. The database was then used for subsequent computation and analysis.

The initial analysis of the database was descriptive. Averages, frequencies and percentages were calculated for various variables in the database. The analysis yielded data that were used for description of the research questions. The data were then presented in form of tables.

3.5 Hypotheses Testing

The hypotheses for this study were tested using analysis of variance (ANOVA), student’s t-test, chi-square test and factor analysis. The Statistical Package for Social Science (SPSS) was used to run these four tests. The significance level was decided at 0.05. When the result of the statistical test was such that the value obtained had a probability of occurrence less than or equal to the significance level, then the null hypothesis was rejected in favour of the alternative hypothesis. If the probability associated with the test result was greater than the significance level, the test results were denoted as non-significant.
3.5.1 Chi-square Test

Chi-square test is a statistical method used to evaluate whether observed frequencies differ significantly from those that would be expected under certain theoretical assumptions (Hammond and McCullagh, 1978). The test can be used to compare data observed against data expected. To apply chi-square test, the following conditions must be fulfilled (Hammond and McCullagh, 1978):

(a) the data must be in the form of frequencies counted within each category (percentages cannot be used),
(b) the total numbers observed must exceed 20,
(c) the expected frequency in any category must not be less than 5,
(d) the observation must be independent, that is, one observation must not influence another.

The formula for computing chi-square value is (Hammond and McCullagh, 1978):

\[ \chi^2 = \sum \frac{(O-E)^2}{E} \]

where: \( \Sigma \) = summation
\( \chi^2 \) = chi-square
\( O \) = observed frequency
\( E \) = expected frequency

The above formula is applied to samples with only one set of variable conditions. The formula may be modified to take into account samples with two or more sets of
variable conditions (Gregory, 1968). Though the basic procedure remains the same, modification is in the computation of expected frequencies and degrees of freedom that are based on probability procedures. The formula takes the form:

\[ \chi^2 = \sum_k \sum_r [(O-E)^2/E] \]

where:  
- \( r \) = rows  
- \( k \) = columns  
- \( \sum_k \sum_r \) = sum over all rows and columns

The expected frequencies \((E)\) are obtained by multiplying the sum of the row by the sum of the column in which the observed frequency occurs and dividing by \( N \), the sum of all the observed frequencies. The degrees of freedom for such a data set is obtained by the formula:

\[ df = (r-1)(k-1) \]

In this study, the test was applied to the hypothesis that there is no significant difference in the means of transport used by men and women in Mwea Tebere Irrigation Scheme. The SPSS was used to compute the chi-square value. Pearson value was used for interpretation. When the Pearson chi-square value had a probability of occurrence less than the chosen significance level (0.05), the null hypothesis was rejected. But when the probability associated with chi-square value was greater than 0.05, the chi-square value is denoted as non-significant.
3.5.2 Student's t-test

Student's t-test is a parametric statistical test used to establish whether or not the differences noted in the means of samples are significant. It can be used to compare the means of two variables for a single group of cases (paired samples) or two different groups of the same variable (independent samples). The formula for computing t-test is (Gregory, 1968):

\[ t = \frac{|a - b|}{\sqrt{\frac{S_a^2}{n-1} + \frac{S_b^2}{n-1}}} \]

Where:
- \( t \) = test statistic
- \( a, b \) = sample means
- \( S_a^2, S_b^2 \) = standard deviations of selected samples
- \( n \) = number of observations

The SPSS was used to compute t-values. The t-value is expressed in terms of its probability. When the t-probability value is less than the chosen level of significance, in this case 0.05, the t-value is said to be significant. T-test was used in this study to establish whether or not differences noted in the average time spent on farming related movement by men and women were significant. It was used to test the hypothesis that there is no significant difference in average time spent on farming related movement by men and women.
3.5.3 One-way Analysis of Variance

Analysis of variance (ANOVA) is a parametric test used to assess the variation between two or more samples. This is achieved by decomposing the total data variance to within- and between-groups component (Shaw and Wheeler, 1985).

To apply the ANOVA, the following conditions need to be fulfilled (Shaw and Wheeler, 1985):

(a) the raw data should be normally distributed,
(b) the sample variances should not be grossly dissimilar.

It should, however, be noted that the ANOVA test is tolerant on both conditions highlighted above (Shaw and Wheeler, 1985). Hence, ANOVA test can still be used even when the data does not meet one of the conditions.

In this study, one-way analysis of variance was used to test the following hypotheses.

\( \text{HO}_1 \): There is no significant difference in average trip lengths travelled daily by farmers in different locations of Mwea Tebere Irrigation Scheme.

\( \text{HO}_2 \): There is no significant difference in average distances travelled between the homestead and the farm by farmers in Mwea Tebere Irrigation Scheme.

\( \text{HO}_3 \): There is no significant difference in average time spent on farming related movement in different locations in Mwea Tebere Irrigation Scheme.
The formula for computing F-value is (Hammond and McCullagh, 1978):

\[ F = \frac{E_o}{E_w} \]

Where:

- \( E_o \) = estimate of population variance based on overall distribution
- \( E_w \) = estimate of population variance based on within samples variance

The SPSS was used to carry out the ANOVA analysis. The computer package computes the F values automatically. It gives both the F-ratio and the F-probability. To interpret the results, F-probability was used. When F-probability is less than or equal to 0.05 (the chosen significance level), the null hypothesis is rejected, implying that there is a difference in the variances. It could therefore be inferred that the difference is a consequence of a difference in locations or values of the means. When the F-probability is greater than 0.05, the F-value is denoted as non-significant.

### 3.5.4 Factor Analysis

Factor analysis is a data reduction technique. Data reduction is important for three main reasons (Johnston, 1980; Dillon and Goldstein, 1984; Shaw and Wheeler, 1985):

(a) to rewrite a data set in an alternative form,

(b) to reduce the number of variables being studied, and

(c) to identify and classify groups of inter-correlated variables.
In this study, the technique was important in identifying and classifying variables relating to transport constraints experienced by farmers in Mwea Tebere Irrigation Scheme into groups of related variables. The technique was used to test the null hypothesis (H0ₗ) that there is no discernible pattern in the rating of transport constraints experienced by farmers in Mwea Tebere Irrigation Scheme.

Factor analysis was preferred to principal component analysis because factor analysis is more appropriate in identifying common patterns among variables (Johnston, 1980; Dillon and Goldstein, 1984). Its strength in this respect, unlike principal component analysis, is that it distinguishes between common and unique variance. Common variance is the proportion of the total variance in the dependent variable accounted for by the combined variances of the independent variables (Johnston, 1980). By focusing on common variance, factor analysis, unlike principal component, is able to simplify complex and diverse relationships that exist among a set of observed variables by uncovering common dimensions or factors that link together the seemingly unrelated variables and consequently provides insight into the underlying structure of the data (Dillon and Goldstein, 1984).

Factor analysis has been successfully used in some geographical studies to classify and interpret variables. Some examples include Mbwesa (1988) on socio-economic factors determining roadside farming in Kiambu District, Kenya; Khayesi (1999) on factors and circumstances perceived by road users as leading to road traffic accidents in Kenya and Kwena (2000) on factors that lead to degradation of Nairobi river basin.
Factor analysis estimates communalities to weight the contribution of each variable to the total common variance. It does this on the basis of the strength of the correlation of each variable with the other variables. This means that the vectors in a correlation matrix representing the variables are not of equal length as they are in principal component analysis in which every variable has the same variance. Thus, the first procedure in factor analysis is the determination of the zero order correlations coefficients among variables (Dillon and Goldstein, 1984). The SPSS was used to generate factor analysis results.

The next stage is to extract factors. The simple correlation matrix is rotated to place the factor in a position in which variables with high correlations (loadings) on it can be isolated. In an ideal situation, every variable should have a loading of +1.0 or −1.0 on one factor and 0.0 on all others (Johnston, 1980). Such an ideal is rarely achieved with real data. Hence, the rotation of the data to approximate to the ideal. Varimax orthogonal rotation that aims at maximising the variance by trying to derive loadings as closer to +1.0 or to 0.0 as possible, thereby increasing the potential contribution of each loading to the total variance accounted for, was used in this study.

Varimax rotation produces factors with factor loadings. The loadings are interpreted as correlation coefficients between the variables and the factor. A decision has to be made concerning which factors are significant and can be retained for further description and analysis. This decision is often made on the basis of eigenvalues, tracer percentage and the scree slope.
Factors with eigenvalues of less than 1.0 are not significant (Johnston, 1980; Dillon and Goldstein, 1984). An eigenvalue is the sum of the squares of factor loadings. When the eigenvalue is expressed as a percentage of the variables (n), it produces a value called percentage of trace that indicates the percentage of variance in the set of variables which is correlated with the factor under consideration. The factors can be used to identify the name to be assigned to each factor (Dillon and Goldstein, 1984).

To determine the cut-off point of significant factors, the scree slope was used. The scree slope is a plot of eigenvalues on a graph in a descending order. The point at which there is a clear break in the slope is interpreted to mean that factors after this point are non-significant.

Having presented the procedures of sampling, data collection and analysis the next three chapters present a discussion of the findings.
CHAPTER 4
STRUCTURE OF FARMING RELATED MOVEMENT IN MWEA TEBERE IRRIGATION SCHEME

4.1 Introduction

This chapter describes the basic features of farming related movement in Mwea Tebere Irrigation Scheme. The variation in these features is examined in relation to respondent's sex, sites of data collection, time spent on travel and crops produced.

The research question addressed is: What are the basic features of farming related movement in Mwea Tebere Irrigation Scheme? The hypotheses tested are:

H01: There is no significant difference in average trip lengths travelled daily by farmers in different locations of Mwea Tebere Irrigation Scheme.

H02: There is no significant difference in average distances travelled between the homestead and the farm by farmers in Mwea Tebere Irrigation Scheme.

H03: There is no significant difference in average time spent on farming related movement in different locations of Mwea Tebere Irrigation Scheme.

H04: There is no significant difference in average time spent on farming related movement by men and women.

H05: There is no significant difference in the means of transport used by men and women.
4.2 Range of Movement

Distance is commonly used to examine the range of movement (Bruton, 1975; Khayesi, 1990; Ogendi, 1992; Odero, 1997). It reveals the spatial extent of movement and therefore the interaction between different people and places. An analysis of trip lengths covered by farmers in Mwea Tebere Irrigation Scheme reveals that about 98% of the daily trips have a spatial extent of up to 4 kms (Table 4.1). It is evident that the number of trips decreases as distance increases. For the entire sample, the mean daily trip length is 2.3 kms. This indicates that short-distance trips dominate daily farming related movement in Mwea Tebere Irrigation Scheme.

Table 4.1: Daily Trip Lengths by Site

<table>
<thead>
<tr>
<th>Trip length in kms</th>
<th>Location (site)</th>
<th>Tebere</th>
<th>Thiba</th>
<th>Karaba</th>
<th>Entire Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>%</td>
<td>Frequency</td>
<td>%</td>
<td>Frequency</td>
</tr>
<tr>
<td>Less than 1</td>
<td>56</td>
<td>36.1</td>
<td>82</td>
<td>59.9</td>
<td>37</td>
</tr>
<tr>
<td>1-4</td>
<td>95</td>
<td>61.3</td>
<td>51</td>
<td>37.2</td>
<td>73</td>
</tr>
<tr>
<td>4.1-8</td>
<td>4</td>
<td>2.6</td>
<td>2</td>
<td>1.5</td>
<td>2</td>
</tr>
<tr>
<td>8.1-12</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>1.5</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>155</td>
<td>100</td>
<td>137</td>
<td>100</td>
<td>112</td>
</tr>
<tr>
<td>Average trip length</td>
<td>3.0 kms</td>
<td>1.7 kms</td>
<td>2.1 kms</td>
<td>2.3 kms</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field data (1999)

These findings concur with findings of other studies on transport in rural areas depending on rainfed agriculture (for example, Kaira, 1983; Ogendi, 1992; Khayesi, 1993,1990; Barwell, 1996; Sieber, 1997). It should, however, be noted that these short trips are the beginning of movement that may cover long distances. For example, crops
such as rice, French beans and tomatoes produced in the Scheme are distributed beyond the local markets to regional, national and international markets. There are firms such as Home Grown, East African Growers, Naiga, Sacco Fresh, Wamu & Wamu Company Ltd and Maina Exporters that buy French beans from farmers in Mwea Tebere Irrigation Scheme and export these products abroad (Wachira and Munene, 2000).

The results in Table 4.1 reveal some variation in trip lengths in the three sites of the Scheme considered in this study. It was therefore deemed important to test the hypothesis that there is no significant difference in average trip lengths travelled daily by farmers in different locations in the study area. The data were subjected to the analysis of variance (ANOVA) and the results are presented in Table 4.2. F-probability value is 0.008 at 0.05 significance level. The F-probability value is less than the chosen significance level. Hence, the null hypothesis is rejected and its alternative hypothesis accepted. This indicates that a significant difference exists in the average daily trip lengths travelled by farmers daily in Mwea Tebere Irrigation Scheme.

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of squares</th>
<th>Degrees of freedom</th>
<th>Mean squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>31.6</td>
<td>2</td>
<td>15.8</td>
</tr>
<tr>
<td>Within Groups</td>
<td>329.6</td>
<td>105</td>
<td>3.14</td>
</tr>
<tr>
<td>F ratio</td>
<td>5.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F significant</td>
<td>0.0082</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Field data (1999)

Variation in trip lengths can partly be explained with respect to the types of crops, besides rice grown in different sites. French beans and tomatoes are mainly grown in
Tebere. The cultivation of these two crops involves several short trips. Farmers make trips to the farm to pick crops, apply fertilisers, irrigate, cultivate, and from the farm to the market to sell the produce and back to the house. Both French beans and tomatoes are marketed immediately after harvesting because they are perishable. This was not the case in Thiba and Karaba where the main crops grown are, maize, beans and green grams. These crops have longer maturing periods compared to French beans and tomatoes and do not have to be transported to the market soon after harvesting. Thus, harvesting and consequently transportation of the grains to the house and/or to the market is not as frequent as is for French beans and tomatoes. The need to transport maize, beans and green grams to the market is indeed occasional and occurs when a farmer needs to sell or dispose them.

The data were analysed further to determine if any difference exists in the trip lengths travelled by men and women. As shown in Table 4.3, about 98% of the trips by both men and women go up to 4 kms. There is no variation in the number of trips made by men and women beyond 4 kms. This trend could be explained by the fact that all the respondents interviewed in the Scheme were at the time of the interviews involved mainly in on-farm, rather than off-farm activities. Consequently, most trips were confined between the homesteads and farms. Distances between homesteads and farms were found to be short (see Table 4.5).
Table 4.3: Trip Lengths Travelled Daily by Men and Women

<table>
<thead>
<tr>
<th>Trip length in kms</th>
<th>Men</th>
<th>Women</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>%</td>
<td>Frequency</td>
</tr>
<tr>
<td>Less than 1</td>
<td>109</td>
<td>44.3</td>
<td>66</td>
</tr>
<tr>
<td>1-4</td>
<td>131</td>
<td>53.3</td>
<td>88</td>
</tr>
<tr>
<td>4.1-8</td>
<td>4</td>
<td>1.6</td>
<td>4</td>
</tr>
<tr>
<td>8.1-12</td>
<td>2</td>
<td>0.8</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>246</td>
<td>100</td>
<td>158</td>
</tr>
</tbody>
</table>

Source: Field data (1999)

The finding that men and women in Mwea Tebere Irrigation Scheme cover almost equal trip lengths does not agree with findings of other studies. For example, Barwell (1996) and Sieber (1997) examined trip lengths covered by men and women and found out that women make shorter trips than men do. The reasons given for this trend is that more women than men are concerned with domestic activities and their movement is often confined within and around the homestead. The emerging trip length in the Scheme can be explained in the light of the policy governing the running of the Scheme. A tenant is supposed to be always working or at all times ready to work on the Scheme when called upon by the management (Kenya, 1986b). This implies that while rural dwellers outside the government schemes could be involved in off-farm employment and therefore be covering long distances to work places, tenants in Mwea Tebere Irrigation Scheme rarely engage in off-farm employment.

Trip length was further analysed by means of transport used. The results of this analysis (Table 4.4) show that trip lengths of less than 1 km are mainly covered on foot. As distances increase, the bicycle and the motor vehicle are used. The bicycle is reported to be faster than walking and therefore preferable for relatively long distances. However,
as the distances increase the use of the bicycle is found to be more tedious and tiresome and the motor vehicle becomes more useful. This finding is at par with findings in Khayesi (1990, 1993) that walking dominates short-trip lengths in rural households but declines in importance as trip length increases giving way to bicycles, motorcycles and motor vehicles. Evidence from Mwea Tebere Irrigation Scheme therefore indicates that this trend does not just apply to the general household trip lengths but also specifically to farming related movement.

Table 4.4: Trip Length by Means of Transport Used

<table>
<thead>
<tr>
<th>Trip length in kms</th>
<th>Bicycle</th>
<th>Walking</th>
<th>Motor vehicle</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency %</td>
<td>Frequency %</td>
<td>Frequency %</td>
<td>Frequency %</td>
</tr>
<tr>
<td>Less than 1</td>
<td>45</td>
<td>27.6</td>
<td>130</td>
<td>56.5</td>
</tr>
<tr>
<td>1-4</td>
<td>112</td>
<td>68.7</td>
<td>98</td>
<td>42.6</td>
</tr>
<tr>
<td>4.1-8</td>
<td>6</td>
<td>3.7</td>
<td>2</td>
<td>0.9</td>
</tr>
<tr>
<td>8.1-12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>163</td>
<td>100</td>
<td>230</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field data (1999)

An analysis of the distance between the homestead and the farm plot reveals that 58.5% of the farms are located within a distance of up to 3 kms from the homesteads (Table 4.5). Only 3.7% of the homesteads are located at a distance of more than 6 kms from the farms.
Table 4.5: Distance between the Homestead and the Farm Plot

<table>
<thead>
<tr>
<th>Distance in kms</th>
<th>Frequency</th>
<th>Per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 3</td>
<td>48</td>
<td>58.5</td>
</tr>
<tr>
<td>3.1 – 6</td>
<td>31</td>
<td>37.8</td>
</tr>
<tr>
<td>6.1 and above</td>
<td>3</td>
<td>3.7</td>
</tr>
<tr>
<td>Total</td>
<td>82</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field data (1999)

On average, the distance travelled between the homestead and the farm for the entire sample is 3.1 kms (Table 4.6). Thus, relatively short distances are travelled between the homestead and the farm. The average distance between the homestead and the farm, however, varies by site as follows: 2.8 kms in Tebere, 3.6 kms in Thiba and 2.9 kms in Karaba.

Table 4.6: Average Distance (kms) Travelled between Homestead and Farm plot

<table>
<thead>
<tr>
<th>Location</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tebere</td>
<td>2.8</td>
</tr>
<tr>
<td>Thiba</td>
<td>3.6</td>
</tr>
<tr>
<td>Karaba</td>
<td>2.9</td>
</tr>
<tr>
<td>Entire sample</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Source: Field data (1999)

To test the hypothesis that there is no significant difference in average trip lengths travelled between the homestead and the farm plot, the data were subjected to ANOVA test. The ANOVA results are presented in Table 4.7. The F-probability value derived (0.324 at 0.05 significance level) was greater than the significance level. This indicates that there is no significant difference in average trip lengths travelled between the homesteads and farm plots.
Table 4.7: ANOVA Results of Distance Travelled between Homestead and Farm

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of squares</th>
<th>Degrees of freedom</th>
<th>Mean square</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>10.7</td>
<td>2</td>
<td>5.4</td>
</tr>
<tr>
<td>Within Groups</td>
<td>371.0</td>
<td>79</td>
<td>4.7</td>
</tr>
<tr>
<td>F ratio</td>
<td>1.1438</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F probability</td>
<td>0.3238</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Field data (1999)

Distances between the homestead and the farm determine the time and monetary costs of transport, which form part of the overall production cost. Such distances determine the intensity of land-use, crop choice and supervision costs (Seeth, Chachnov and Surinov, 1998). Where distances to farm plots are short, intensive production is possible as time and cash expenditure to get to the plots are reduced. In Mwea Tebere Irrigation Scheme, the current intensive production of tomatoes and French beans can partly be attributed to distances between the farms and the homesteads. As already stated, production of tomatoes and French beans involves a lot of movement to the farm to cultivate, plant, irrigate, apply fertilisers and harvest. The labour needed for these activities is high and with short distances to the farm, less time is spent on travel between the farm and the homestead and therefore saving time for work on the farm. In the next sub-section, results of an analysis of time spent in farming related movement are presented.

4.3 Time Spent on Farming Related Movement

In addition to trip length, time spent to complete a trip is also used to examine the range of movement (Bruton, 1975; Barwell, 1996; Sieber, 1997; Seeth, Chachnov and
Surinov, 1998). Time spent on movement reveals the transport burden an individual has to bear to accomplish a task or achieve the purpose of trip making. The amount of time spent on movement affects the time available for farming and other productive activities.

The average time spent on all movements and on farming related movement is examined in this section. The results shown in Table 4.8 reveal that the average time spent daily (1 day = 12 hours) by all the respondents on all movements is about 1 hour and 52 minutes. This is the time spent on movements aimed at accomplishing a household’s activities including domestic, leisure, off-farm and on-farm activities. Farming related movement takes an average of 1 hour and 15 minutes. This is 67% of the time spent on all movements. This implies that 33% of the time spent on movement is on non-farm activities such as water and firewood collection, food preparations and leisure among others.

Table 4.8: Average Time Spent on All Movements and Farming Related Movement

<table>
<thead>
<tr>
<th></th>
<th>All movements</th>
<th>Farming-related</th>
<th>% of farming movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>All respondents</td>
<td>1 hour 52 minutes</td>
<td>1 hour 15 minutes</td>
<td>67</td>
</tr>
<tr>
<td>Tebere</td>
<td>2 hours 8 minutes</td>
<td>1 hour 21 minutes</td>
<td>63</td>
</tr>
<tr>
<td>Thiba</td>
<td>1 hour 34 minutes</td>
<td>1 hour 9 minutes</td>
<td>73</td>
</tr>
<tr>
<td>Karaba</td>
<td>1 hour 51 minutes</td>
<td>1 hour 25 minutes</td>
<td>77</td>
</tr>
</tbody>
</table>

Source: Field data (1999)

Table 4.9 further illustrates the time spent in farming related movement in Mwea Tebere Irrigation Scheme. This table reveals that over half of the time spent by farmer A in all movements is spent in farming related movement. These results indicate the
importance of farming in Mwea Tebere Irrigation Scheme. Farming in the study area involves a lot of movements and consequently a lot of time is spent on such movements. Hence, if the transport burden on the farmer can be managed by reducing the time spent on movement, more time may be allocated to productive farming.

Table 4.9: Daily Time Allocation to Various Activities by Farmer A

<table>
<thead>
<tr>
<th>Duration</th>
<th>Activity</th>
<th>Amount of time spent</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 a.m. - 6.30 a.m.</td>
<td>Cycles to the farm</td>
<td>30 minutes</td>
</tr>
<tr>
<td>6.31 a.m. - 11.30 a.m.</td>
<td>Top dresses French beans and supervises labour on farm</td>
<td>5 hours</td>
</tr>
<tr>
<td>12.00 noon - 12.30 p.m.</td>
<td>Cycles home</td>
<td>30 minutes</td>
</tr>
<tr>
<td>12.31 p.m. - 1 p.m.</td>
<td>Eats lunch</td>
<td>30 minutes</td>
</tr>
<tr>
<td>1.01 p.m. - 1.20 p.m.</td>
<td>Cycles to the market</td>
<td>20 minutes</td>
</tr>
<tr>
<td>1.21 p.m. - 3.30 p.m.</td>
<td>Oversees the sale of his French beans in the market</td>
<td>2 hours and 10 minutes</td>
</tr>
<tr>
<td>3.31 p.m. - 4.10 p.m.</td>
<td>Cycles to the shopping centre for social activities</td>
<td>40 minutes</td>
</tr>
<tr>
<td>4.11 p.m. - 5.20 p.m.</td>
<td>Chats with friends</td>
<td>1 hour and 10 minutes</td>
</tr>
<tr>
<td>5.21 p.m. - 5.50 p.m.</td>
<td>Cycles home to rest</td>
<td>30 minutes</td>
</tr>
</tbody>
</table>

Farmer A grows French beans in Tebere. This farmer spends at least 2 hours and 30 minutes on all movements by the end of the day. Out of this time, about 1 hour and 20 minutes (53% of the time spent in all movements) are spent on farming related movements. This farmer spends about 60% of the time available to him daily on productive farming.

Source: Field data (1999)

Time spent was further analysed by sites of the study area. The findings presented in Table 4.8 indicate that on average, farmers in Tebere spend 2 hours and 8 minutes, those in Thiba 1 hour and 34 minutes and those in Karaba 1 hour 51 minutes in all movements. The average time spent in farming related movement in Tebere is 1 hour and 21 minutes, in Thiba 1 hour 9 minutes and in Karaba 1 hour and 25 minutes. These
results reveal that in the three sites of the study area, more than 60% of the time spent in all movements is used in farming related movement.

To test the null hypothesis that there is no significant difference in average time spent on farming related movement in the different sites of Mwea Tebere Irrigation Scheme, the data in Table 4.8 were subjected to the analysis of variance (ANOVA). The F-probability value associated with F-ratio was 0.349 at 0.05 significance level (Table 4.10). The F-probability is greater than the significance level indicating that there is no significant difference in time spent on farming related movement in the three sites in Mwea Tebere Irrigation Scheme.

Table 4.10: ANOVA Test Results of Time Spent on Farming Related Movement

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of squares</th>
<th>Degrees of freedom</th>
<th>Mean of square</th>
<th>F ratio</th>
<th>F probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>5010.5</td>
<td>2</td>
<td>2505.2</td>
<td>1.0635</td>
<td>0.3489</td>
</tr>
<tr>
<td>Within Groups</td>
<td>247336.5</td>
<td>105</td>
<td>2355.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Field data (1999)

Time spent on movement varies with the means of transport used as shown in Table 4.11. As expected, farmers using motor vehicles spent the shortest time (10 minutes) on average. The average time spent in all movements using a bicycle and walking was approximately 1 hour 56 minutes and 1 hour 51 minutes, respectively. Although relatively more time is spent to accomplish farming related movements using a bicycle, the bicycle is still faster than walking. Besides, a farmer using a bicycle is able to
diversify his or her activities as illustrated in Table 4.9. The bicycle, therefore, goes far in improving transport services available to the farmer as it increases accessibility.

Table 4.11: Average Time Spent on All Movements and Farming Related Movement by Means of Transport Used

<table>
<thead>
<tr>
<th>Means of transport</th>
<th>All movement</th>
<th>Farming related movement</th>
<th>% of farming related movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bicycle</td>
<td>1 hour and 56 minutes</td>
<td>1 hour and 13 minutes</td>
<td>63</td>
</tr>
<tr>
<td>Walking</td>
<td>1 hour and 51 minutes</td>
<td>1 hour and 22 minutes</td>
<td>74</td>
</tr>
<tr>
<td>Motor vehicle</td>
<td>10 minutes</td>
<td>10 minutes</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field data (1999)

The importance of time cost in transport related to agricultural activities or household food production has been highlighted in other transport studies (Barwell, 1996; Seeth, Chachnov and Surinov, 1998). Seeth, Chachnov and Surinov (1998) argue that the time and cash expenditure to and from dachas and plots of rural households are important factors for land use intensity in Russia. Majority of urban households in Russia spend more than one hour to get to their dachas. In rural areas and villages, most people spend less than 15 minutes to get to their farm plots and only 3% spend more than one hour.

The time spent in travel determines the amount of time available to work on the farm, such that "for an additional 10 minutes of travel, work time is reduced by 33 hours per annum" (Seeth, Chachnov and Surinov, 1998: 1621). Thus, if only 10 minutes could be saved on travel, work time could be increased by 33 hours per annum. This time saving has important implications in the life of people: more time would be spent on domestic activities, in on-farm and off-farm employment. This would consequently raise the living standards of people.
The time aspect was also analysed by sex. The results of this analysis shown in Table 4.12 reveal that on average, both men and women spent about 1 hour and 52 minutes on all movements. The average time spent on farming related movement is 1 hour 19 minutes for men and 1 hour and 16 minutes for women. The proportion of time spent by men and women in relation to the time spent on all movement is 71% and 68%, respectively.

Table 4.12: Average Time Spent on All Movements and Farming Related Movement by Sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>All movements</th>
<th>Farming movement</th>
<th>related</th>
<th>% of farming related movement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>1 hour and 52 minutes</td>
<td>1 hour and 19 minutes</td>
<td>71</td>
<td></td>
</tr>
<tr>
<td>Woman</td>
<td>1 hour and 52 minutes</td>
<td>1 hour and 16 minutes</td>
<td>68</td>
<td></td>
</tr>
</tbody>
</table>

Source: Field data (1999)

To test the hypothesis that there is no significant difference in average time spent on farming related movement by men and women, the data were subjected to the student’s t-test. The t-test results indicate a significant difference in average time spent in farming related movement by men and women (Table 4.13). The p-value is 0.000 at 0.05 level of significance. This value is less than 0.05. Hence, the null hypothesis is rejected in favour of the alternative hypothesis. This means that men spend more time on farming related movement than women do in Mwea Tebere Irrigation Scheme. This difference could partly be explained in that women, unlike men, spend part of their time to accomplish domestic activities alongside farming related activities. For example, female respondents had to prepare breakfast and fetch water in the morning before going to the farm. In addition, farmers in Mwea Tebere Irrigation Scheme are tenants who are
basically expected to be always attending to the development of the Scheme (Kenya, 1986b). As a result, most men are involved in on-farm other than off-farm employment.

Table 4.13: T-test Results for Time Spent on Farming Related Movement by Men and Women

<table>
<thead>
<tr>
<th>T-test analysis</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Standard error</th>
<th>t-value</th>
<th>Degrees of freedom</th>
<th>2-tail probability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>112</td>
<td>48.69</td>
<td>2.422</td>
<td>-32.29</td>
<td>403</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Source: Field data 1999

4.4 Transportation of Main Crops in Mwea Tebere Irrigation Scheme

The main crops grown in Mwea Tebere Irrigation Scheme are rice, maize, beans, French beans and tomatoes. Rice is produced on a relatively higher acreage in the Scheme. Each farmer is allocated 4 acres to grow rice and 2 acres outside the paddy field for other crops. The areas outside the paddy fields are small and are diminishing due to population increase. Rice is therefore produced in large quantities than other crops (Table 4.14). It should, however, be noted that whether the crop is produced in small or large quantities, there is need to transport it from the farm to the market and/or homestead.

Table 4.14: Average Amount of Crop Yields for the 1998/99 Crop Year

<table>
<thead>
<tr>
<th>Crop Type</th>
<th>Average (kgs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td>4821</td>
</tr>
<tr>
<td>French beans</td>
<td>196</td>
</tr>
<tr>
<td>Tomatoes</td>
<td>753</td>
</tr>
<tr>
<td>Maize</td>
<td>769</td>
</tr>
<tr>
<td>Beans</td>
<td>92</td>
</tr>
</tbody>
</table>

Source: Field data (1999)
French beans and tomatoes are mainly grown for marketing; beans and maize for subsistence; and rice for both marketing and subsistence. Different means of transport are used in transporting these crops. Seventeen of the 23 households that grow French beans use human porterage to transport the produce from the farm to the market and/or "shade". Tomatoes are sold at the farm gate to middlemen. These buyers provide the means of transport, with many of them using pickups, mini-buses and lorries.

Animal-drawn carts are the main means of transport used for the transport of maize and beans from farm plots to the homestead. About 25 and 40 of the 40 and 52 households growing beans and maize, respectively use animal-drawn (ox and donkey) carts to transport these crops from the farm to the homestead. The reason for using animal-drawn carts was the bulkiness of these crops. In addition, many respondents own oxen not only as a means of transport but also as draught animals. Hence, those who do not own oxen could borrow or hire from their neighbours. Animal-drawn carts and motor vehicles (lorries and tractors) are the main means of transport used for the transportation of rice. Animal-drawn carts are used for transportation of rice to the homestead while motor vehicles are used to transport rice to National Irrigation Board and farmers’ cooperative society stores within the Scheme as well as to local and regional markets.

Daily trips made by farmers often involve carrying light farm implements, farm inputs and outputs of different sizes and weights. The items carried include pangas, jembes, jerry cans, bags of fertiliser, rice, water pumps, pipes and seeds. Their weights range
from less than 1 kg to above 20 kgs (Table 4.15). About 80% of the respondents carried load sizes of less than 10 kgs.

Table 4.15: Load Size of Farm Implements, Inputs and Outputs Carried Daily by Farmers

<table>
<thead>
<tr>
<th>Load size in kgs</th>
<th>Number of Respondents</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10</td>
<td>86</td>
<td>79.6</td>
</tr>
<tr>
<td>10-20</td>
<td>20</td>
<td>18.5</td>
</tr>
<tr>
<td>21 and above</td>
<td>2</td>
<td>1.9</td>
</tr>
<tr>
<td>Total</td>
<td>108</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field data (1999)

The foregoing discussion reveals that non-motorised means of transport (human porterage, bicycle, ox- and donkey-drawn carts) play a significant role in the initial stages of a long chain of transactions that begins at the farm level. These means of transport contribute immensely to the bulking of goods at the local stores and markets. For example, after picking French beans, farmers transport this crop to the “shade” where sorting and grading is done, the produce is further transported from this local market to the firm’s premises where packaging for export takes place.

The importance of non-motorised means of transport in meeting the rural transport needs is widely recognised (Chiteji, 1980; Kaira, 1983; Khayesi, 1990; Ogendi, 1992; Nanzala, 1996; Odero, 1997; Kipke and Fernando 1998). As a result, a lot of investment and research is directed towards their improvement (Riverson and Carapetis, 1991; Calvo, 1994a, 1996; Okeaduh, 1995; Barwell, 1996, Nanzala, 1996; Salifu 1998). Whereas a lot of modification has been done to improve non-motorised means of transport, there is still more to be done (Ellis and Hine, 1998). These means of transport
have some limitations, especially with respect to transporting heavy loads and time taken to complete a trip. For example, the load weight carried by an adult is usually limited to 25-35 kgs (Barwell et al. 1978 cited in Kaira, 1983). In Mwea Tebere Irrigation Scheme, the load carried by an adult was mainly less than 30 kgs. Such small load weights imply that one has to make more than one trip if he or she has to transport loads weighing more than 35 kgs. Consequently, more time is spent in transport. Besides, human porterage can cause injury or deformity particularly if one falls when carrying a heavy load.

Bicycles are limited in the load weight carried largely due to lack of carts or trailers attached to the rear. A trailer is a "two-wheeled cart which hitches to the back of the bicycle and can be unhitched when not needed" (Barwell, 1996:9). In Mwea Tebere Irrigation Scheme, for example, bicycles do not have attachments to improve their load carrying capacity. Hence, rural transport planners should consider giving the non-motorised means of transport the attention they deserve.

Despite the fact that the all-weather Embu-Nairobi road passes through Mwea Tebere Irrigation Scheme and is in close proximity to most villages in Thiba and a few in Tebere, this road has not contributed in promoting the usage of motor vehicles in satisfying the farm level transport needs. There is low usage of motor vehicles compared to walking and use of bicycles (Table 4.16). The explanation for this is that most trips are between homesteads and farms. The distances between homesteads and farms are usually short (see Table 4.5) and mainly undertaken using bicycles and
walking. Motor vehicles are, however, used in long distance-travel of over 8 kms. Kaira (1983), Nalo (1994), Howe (1998,1996), Sieber (1998,1997) and Tichagwa (2000) have observed that although roads and motor vehicles are essential for long distance transport, they cannot fully solve the problem of rural transport. This is largely because of the short distances involved. Hence, the importance of intermediate means of transport such as bicycles, animal-drawn carts and hand-drawn carts to supplement and complement motorised transport in rural areas.

The results presented in Table 4.16 reveal that footpaths dominate all the trips. They are followed by gravel roads and paved roads in that order. These results indicate the importance of footpaths and gravel roads in transport at the farm level. Similar findings on the dominance of the use of the bicycle and walking on footpaths and gravel roads in rural travel have been revealed in studies by Kaira (1983), Ogendi (1992), Khayesi (1993, 1990), Calvo (1994b), Salifu (1995), Okeaduh (1995) and Sieber (1997). There is need to clear bushes and put murram on these routes to improve rural accessibility and connectivity. The routes link the villages to tarmac roads and consequently to other regions. They particularly link the farmer to local, regional and national markets. Thus, as Khayesi (1990) suggested, there is need to widen and improve footpaths and tracks so that they can be used by motor vehicles, where possible.
Table 4.16: Means of Transport Used by Nature of Route

<table>
<thead>
<tr>
<th>Route used</th>
<th>Bicycle Frequency</th>
<th>Bicycle %</th>
<th>Walking Frequency</th>
<th>Walking %</th>
<th>Motor vehicle Frequency</th>
<th>Motor vehicle %</th>
<th>Total Frequency</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Footpath</td>
<td>84</td>
<td>32.6</td>
<td>174</td>
<td>67.4</td>
<td>0</td>
<td>0</td>
<td>258</td>
<td>63.9</td>
</tr>
<tr>
<td>Gravel</td>
<td>53</td>
<td>52.0</td>
<td>42</td>
<td>41.2</td>
<td>7</td>
<td>6.9</td>
<td>102</td>
<td>25.2</td>
</tr>
<tr>
<td>Tarmac</td>
<td>11</td>
<td>64.7</td>
<td>2</td>
<td>11.8</td>
<td>4</td>
<td>23.5</td>
<td>17</td>
<td>4.2</td>
</tr>
<tr>
<td>Footpath/Gravel</td>
<td>7</td>
<td>46.7</td>
<td>8</td>
<td>53.3</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>3.7</td>
</tr>
<tr>
<td>Footpath/tarmac</td>
<td>2</td>
<td>33.3</td>
<td>4</td>
<td>66.7</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>1.5</td>
</tr>
<tr>
<td>Gravel/tarmac</td>
<td>6</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td>163</td>
<td>40.3</td>
<td>230</td>
<td>56.9</td>
<td>11</td>
<td>2.7</td>
<td>404</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field data (1999)

Table 4.17 shows that the bicycle is used in about 62% of all daily trips made by men. This contrasts sharply with women who make most (89.9%) of their trips on foot. This reveals the burden and drudgery of rural travel on women who are involved in a number of productive activities. The difference in walking and use of the bicycle by men and women can be explained by the fact that most households own only one bicycle, which is mainly used by male members of that household. Bicycles are accessible to other household members only when the males are not using them. In addition, other factors such as cultural beliefs and attitudes hinder the use of the bicycle by women. A discussion with a woman respondent who owns a bicycle revealed that some people believe that bicycle cycling by women does not portray “modesty” and that women involved in cycling would reduce their fertility rate. To this respondent, this is just prejudice. Similar hindrances to cycling by women have been reported not only in Kenya (Kaira, 1983) but other parts of Africa (Overton, 1996; Calvo, 1996; Kipke and Fernando, 1998; Olinga, 2001).
Table 4.17: Means of Transport Used by Sex  

<table>
<thead>
<tr>
<th>Sex</th>
<th>Means of Transport Used</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bicycle</td>
<td>Walking</td>
</tr>
<tr>
<td></td>
<td>Frequency</td>
<td>%</td>
</tr>
<tr>
<td>Men</td>
<td>152</td>
<td>61.8</td>
</tr>
<tr>
<td>Women</td>
<td>11</td>
<td>7.0</td>
</tr>
<tr>
<td>Total</td>
<td>163</td>
<td>40.3</td>
</tr>
</tbody>
</table>

Source: Field data (1999)

A chi-square test was run to test the hypothesis that there is no significant difference in means of transport used by men and women. The probability associated with pearson chi-square value was 0.0 at 0.05 significance level (Table 4.18). This value is less than 0.05 indicating a significant difference between the means of transport used by men and women. The null hypothesis is rejected in favour of its alternative hypothesis.

Table 4.18: Chi-square Results of Means of Transport Used by Men and Women

<table>
<thead>
<tr>
<th>Chi-square</th>
<th>Value</th>
<th>Degrees of freedom</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson</td>
<td>121.33</td>
<td>2</td>
<td>0.000</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>138.98</td>
<td>2</td>
<td>0.000</td>
</tr>
<tr>
<td>Linear-by-Linear Association</td>
<td>57.22</td>
<td>1</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Source: Field data (1999)

4.5 Summary

A description of the basic features of farming related movement in Mwea Tebere Irrigation Scheme has been presented in this chapter. The findings reveal that farming related travel in the Scheme is generally characterised by short distances, predominantly on footpaths and tracks and undertaken mainly by walking and use of bicycles. Low volume goods are also a feature of farm transport in Mwea Tebere Irrigation Scheme.
The daily trip lengths, however, vary from one site of the scheme to another, that is 3 kms, 1.7 kms and 2.1 kms for Tebere, Thiba and Karaba, respectively. A statistical analysis of this variation using the ANOVA has found it to be significant.

Men and women use different means of transport to accomplish their travel and transport needs. While most men use bicycles, women accomplish most of their journeys on foot. A chi-square test has revealed that there is a significant difference between the means used by men and women.

Different means of transport are used to transport crops in Mwea Tebere Irrigation Scheme. Human porterage is commonly used for the transport of French beans to the “shade” and/or markets. Middlemen, using pick-ups or lorries provide transport for tomatoes at the farm-gate. Ox- and/or donkey-drawn carts are used to transport maize and beans. Animal-drawn carts, lorries and tractors are used in transportation of rice. Transportation at the farm level forms the initial stages of a long chain of transport logistic chain.

The average time spent daily by all respondents in all movements is 1 hour and 52 minutes. Sixty seven per cent of this time is spent on farming related movement. A student’s t-test reveals that men spend significantly more time than women do in farming related movement.
Having presented the basic features of farming related movement, the next chapter discusses the provision of transport service to farmers in Mwea Tebere Irrigation Scheme.
CHAPTER 5
ORGANISATION AND PROVISION OF TRANSPORT SERVICE TO
FARMERS IN MWEA TEBERE IRRIGATION SCHEME

5.1 Introduction

The discussion in chapter 4 reveals that farmers in Mwea Tebere Irrigation Scheme are involved in daily trips, covering varying distances and moving different volumes of goods. They use different means of transport and travel on various routes. These variations have led to the emergence of different organisational arrangements to provide the transport service needed by farmers.

This chapter discusses the organisation in the provision of transport service to farmers in Mwea Tebere Irrigation Scheme. This is done with an objective to examine how transport is organised by various agents to meet the needs of farmers in the study area. The research question addressed in this is: how do farmers meet their farming related transport needs?

5.2 Provision of Transport Service

Transport service in Mwea Tebere Irrigation Scheme is provided by governmental and private agencies. The structure and role of different agencies are discussed in this section.
5.2.1 Government Sector through the National Irrigation Board

In Mwea Tebere Irrigation Scheme, both the National Irrigation Board and farmers carry out the production and marketing of rice. The Board and the farmers are therefore responsible for the transportation of farm inputs and outputs related to rice production.

5.2.1.1 Transport of Inputs by the National Irrigation Board

The National Irrigation Board advertises in the daily newspapers for tenders to supply fertilizers, pesticides, insecticides and gunnysacks to the Scheme. The tender winner is expected to ensure that these inputs are transported to the Board's premises (collection stores) in the Scheme. From the collection stores, the Board offers transport services for fertilizers, pesticides and insecticides to the paddy fields. The Board uses its lorries and tractors to transport these inputs. Farmers are given this service on credit and payment is done through deductions from crop sale. Farmers collect gunnysacks (packaging bags), from the collection stores during the harvesting season.

5.2.1.2 Transport of Rice

The Board advertises in the daily newspapers for tender to transport rice from the field to the collection stores. In the collection stores, rice is dried and packed in standard 75-kg bags. Once this is done, the Board goes ahead to market the rice on behalf of the farmers. It is important to note that since 1998 up to the present, the Scheme has been
experiencing a crisis between farmers and the National Irrigation Board over the marketing of rice (Mwai, 2000). Consequently, the farmers, through their co-operative society, have taken over the marketing of rice. The farmers have thus been delivering rice to the co-operative's premises.

A focus group discussion aimed at establishing the root cause of the crisis revealed that the bone of contention was the pricing of rice. Transport was identified as a factor contributing to farmers' dissatisfaction with the Board. The focus group discussion observed that under the Board's management, they could not transport any rice from the paddy fields for their subsistence use before the harvesting season. In addition, the respondents complained that even during harvesting season, the Board enforced directives and deployed tight security to ensure that only the 12–14 bags officially permitted were carried home by an individual farmer depending on his or her production. The farmers, therefore, had always to depend on transport services offered by the Board.

The respondents pointed out that the tender winners hardly had enough vehicles to meet their transport demand for rice transport. Due to low vehicle fleet, farmers waited for long before their rice was transported from the farm to the store. As a result, the affected farmers spent days and nights in the paddy fields to provide security for their produce. This problem of the low supply of vehicles is explained in the monopolistic system of providing transport service. The problem of high transport demand and low supply of transport services has been reported in studies by Kamulali (1977) and Porter
Kamulali (1977) found out that Tanzania Cotton Authority monopolised the distribution of goods in Bukoba. This Authority had a small vehicle fleet and did not supply the services to farmers satisfactorily. Kamulali (1977) further found out that the National Milling Corporation monopolised the collection of non-perishable products such as legumes and grains from rural and market centres to Bukoba market for processing and redistribution. The Corporation, however, had a low truck fleet. This led to some of the food products remaining uncollected in rural areas for a long period of time resulting to spoilage. It is evident from the foregoing discussion that the government sector has not been effective in providing the transport service to farmers. Hence, farmers make private transport arrangements to complement the government's services.

5.2.2 The Private Sector

5.2.2.1 Farmers' Co-operative Society

In-depth interviews with farmers revealed that the farmers' co-operative society was in operation prior 1998/99 crop-year when the marketing crisis erupted in Mwea Tebere Irrigation Scheme. The co-operative was, however, never co-opted by the National Irrigation Board in the production and marketing of rice. Instead, the cooperative performed other duties such as giving loans to farmers.
Beginning the 1998/99 crop-year, the farmers' co-operative society became responsible for the production and marketing of rice. This shift of responsibility from the National Irrigation Board to the farmers' co-operative society came about when some farmers refused to deliver their 1998/99 rice produce to the National Irrigation Board stores in Ngurubani. Instead, farmers delivered the harvest to the farmers' co-operative society. At the moment, the co-operative provides all the services that the National Irrigation Board had been providing for years. Concerning transport, the society is following all that the board had been doing. However, it is doubtful as to whether or not the co-operative society will continue performing this role in the future. This is because the rice marketing crisis continued into the 1999/2000 and 2000/2001 crop-years, with farmers being indifferent as to whether or not to deliver the paddy to the Board's or co-operative's premises (Munene and Waweru, 2000; Mwai, 2000). Farmers are asking for meaningful participation in marketing rice. This was revealed in farmers' comment "we want soko huru" (free market) during a focus group discussion. The farmers' co-operative society, just as the Board, is not concerned with the production of other crops in the Scheme.

5.2.2.2 Individual Transport Arrangements

Farmers make their own arrangements for the provision of transport services. Various means of transport are available for the farmers' use. These include human porterage, animal-drawn carts, bicycles and motor vehicles. These are discussed in the following sections.
5.2.2.2.1 Human Porterage

In Mwea Tebere Irrigation Scheme, human porterage is basically a woman’s activity. Women carry loads on their backs (Plate 5.1). Human porterage is a common sight in the areas growing French beans. After picking the French beans, women transport the crop to a “shade” located within or outside the farm. They carry an average load of between 18-30 kgs per person. A ‘shade’ is a shelter that is temporarily built to serve as a collection centre. In this centre, French beans are sorted, graded and packaged in three-kilogram boxes ready for sale.

The importance of human porterage, especially by women in rural areas, has been reported in the following studies: Kaira (1983), Ogendi (1992), Riverson and Carapetis (1991), Heyen-Perschon (1998, 2001). Ogendi (1992) and Kaira (1983) observe that head, shoulder and back loading are used for transportation of light goods.

Plate 5.1: Women Carrying Bags of Maize on their Back to the Market in Mwea Tebere Irrigation Scheme
Source: Photo by author
5.2.2.2 The Bicycle

The bicycle is an important means of personal travel as well as transport of agricultural goods (Kaira, 1983; Okeaduh, 1995; Salifu, 1995; Calvo, 1996, 1994a,b; Nanzala, 1996; Odero, 1997; Sieber, 1997; Heyen-Perschon, 1998, 2001). In Mwea Tebere Irrigation Scheme, the bicycle is the second major means of transport after walking. It is used by the farmer to take him or her to the farm and he or she can carry light loads such as jembes, pangas, water pumps and bags of fertilisers. The bicycle is used to carry loads with an average weight of 50 kgs, though loads of approximately 100 kgs were reported and seen carried by this means (Plate 5.2).

Plate 5.2: A Bicycle Rider Transporting a Bag of Rice to the Market
Source: Photo by author

Farmers who own at least a bicycle and grow French beans and/or tomatoes reported that they irrigated their crop fields twice a day (in the morning and evening). Farmers who did not own a bicycle and therefore had to walk to the farm, irrigated their fields only once (either in the morning or in the evening). Thus, the bicycle is an important
means of transport at the farm level. It extends the level of activities carried out by a farmer. This does not only apply to Mwea Tebere Irrigation Scheme but also to other places. For example, Sieber (1997) reports that households that use bicycles in Makete District in Tanzania are able to cultivate bigger fields and use more fertiliser than those that do not use bicycles. A household owning a bicycle in Makete, markets two fifths more than comparable households that do not own any intermediate means of transport. Heyen-Perschon (2001) found out that the bicycle extends activity for households in rural Uganda.

5.2.2.2.3 Animal Transport

Farmers rear oxen not only for draught cultivation but also for transport purposes. Hence, they use oxen and donkeys to transport some of their agricultural products. At least three quarter of the households interviewed in Mwea Tebere Irrigation Scheme own oxen. Donkeys are owned by a few farmers and are used for transport purposes only. Whereas the oxen are used for transport of agricultural commodities from the farm to the house, house to the market and market to the house and/or farm (Plate 5.3), donkeys are in addition used to ferry water from rivers and/or canals to the shopping centres for sale. Although it could not be established from the interviews the exact distances covered by oxen and donkeys, the respondents reported that oxen cover shorter distances than donkeys. In Mwea Tebere Irrigation Scheme, animal carts are greatly used during planting and harvesting seasons to transport bulky loads such as
bags of rice, maize, beans, fertilizers and seeds. The cart attachment increases the carrying capacity of an animal as illustrated by plate 5.3.

The use of animal-drawn cart to meet farming-related transport needs has been reported in other studies. Kaira (1983) reports that animal carts are the main ways of transporting manure, seeds and farm equipment to the farms during sowing seasons in many developing countries. They are also used to transport produce to the market, stores and/or houses during the harvesting period. In addition, animal transport is useful in transporting firewood and water for households. Sieber (1997) in a study in Makete District in Tanzania reports: “the use of donkeys by farmers earned them the highest monetary benefits of approximately $91 compared to use of bicycles which earned about $2. Households using donkeys marketed twice as much as households without any intermediate means of transport” (Sieber, 1997:17).

Some farmers in Mwea Tebere Irrigation Scheme use oxen and/or donkeys for commercial purposes (Plate 5.3). Farmers who do not own animal-drawn carts go for this alternative. Individuals involved in offering such transport services do it at a cost. The charges per every customer depend on the size of their loads and the trip lengths. The longer the trip or the heavier the load, the higher the cost of transport. As a result, farmers prefer paying for such services individually due to variation of load sizes and distances covered. An in-depth interview with a farmer revealed that to transport a bag of fertiliser (50 kgs) for about 5 kms cost a farmer Kshs. 20 while to transport the same load for 10 kms, Kshs. 35 was paid.
Farmers prefer animal transport to motor vehicles because, unlike the motor vehicle operators, animal transport operators offer door-to-door services. Farmers trust animal transport entrepreneurs as they come from their locality. Trust is important in this arrangement as service users do not usually accompany their goods but use other means to travel home and/or to the market. This arrangement is common during market days.

Although the findings of the current study reveal that animal transport is important in Mwea Tebere Irrigation Scheme, it should be noted that the Irrigation Act laws of Kenya chapter 347 forbids a farmer to keep any livestock on his/her farm holding other than those specified in his licence. In addition, the farmer is expected to declare to the manager annually the natural increase in such stock and comply with any instructions issued by the manager as to their disposal (Kenya, 1986b). This implies that the farmer is only allowed to keep a limited number of livestock. If a farmer cannot afford to hire animal transport,
he/she is only left to depend on human porterage. This situation is further compounded by the requirement that a farmer should not hire, or employ livestock or machinery for land preparation, other than livestock or machinery owned by the manager. Whenever a farmer is to do this he/she should seek approval in writing from the manager (Kenya, 1986b).

5.2.2.2.4 Motor Vehicle Transport

None of the respondents in the study area owned a motor vehicle. Farmers, however, occasionally hire motor vehicles to transport bulky agricultural products such as rice, maize and beans. This is particularly the case where the cost of hire of motor vehicle is the same as the cost of hiring animal carts. The use of motor vehicles in the Mwea Tebere Irrigation Scheme is also influenced by the policy running the activities in the Scheme. The Irrigation Act laws of Kenya chapter 347 states that there should be no person who causes any motor vehicle to be driven within the Scheme over any road other than the Public Roads and Roads of Access unless he is in possession of a permit issued by the manager (Kenya, 1986b). Even after getting the permit, the holder must comply with all conditions stipulated on it.

The respondents reported that it cost them Kshs. 50 using either a pick-up or animal-drawn cart during the 1998/1999 rice harvesting season to transport a bag of rice weighing approximately 90 kgs from the farm to the house, a distance of about 5 kms. Thus, when the cost of hiring motor vehicles is far above that of hiring animal-carts, the
latter is preferred to the former. Besides hiring pick-ups and lorries purposely for transport of goods, farmers also use *matatus* for transport of goods (Plate 5.4). Discussions with respondents revealed that *matatus* serving areas such as Karaba that are removed from the Embu-Nairobi all-weather road increase in number during market days to meet the heightened transport demand.

Plate 5.4: A *Matatu* Transporting Goods and Passengers to Makutano Market  
Source: Photo by author

5.2.2.3 Itinerant Traders

Itinerant traders, also referred to as brokers or middlemen by farmers, move around in rural areas buying crop produce from farmers. In the study area, itinerant traders are involved in buying tomatoes and French beans at the farm gate (Plate 5.5). Horticultural export companies are the main itinerant traders in French beans trade (Plate 5.6). Where the "shade" is not within the farm, the company lorries transport the produce from the farm-gate to a central "shade", where sorting and grading of the produce take place. Such transport services are not provided by all the buying companies. The companies
providing transport services from the farm gate to a "shade" do not charge farmers for the service rendered. This "free" service is aimed at encouraging farmers to sell the produce to these companies when the crop demand at the market is high and supply low.

Farmers reported dissatisfaction with the prices offered by itinerant traders but they still depended on them. The respondents pointed out that if one was to transport his/her produce to big markets such as *Wakulima* in Nairobi, great loss could be incurred
because of transport and other costs. Wachira and Munene (2000) have reported exploitation of farmers in Mwea Tebere Irrigation Scheme by middlemen as their crops are bought at low prices. Farmers' exploitation by middlemen has also been reported in Ogendi (1992) who points out that whereas it may be true that the burden of transporting farm produce to the market is seemingly solved by sales at the farm gate, the farmer whose produce is purchased at low prices might make little or no profit at all.

5.3 Summary

In this chapter, the structural organisation in the provision of transport services to farmers in Mwea Tebere Irrigation Scheme has been discussed. Farmers make various arrangements for meeting their farming related transport needs. While on one hand, the government provides transport services to farmers through the National Irrigation Board, on the other, under the private sector, the following agents are involved: farmers' co-operative society, individual farmers and itinerant traders. Thus, both the government and private sectors complement each other in meeting the transport needs of farmers in Mwea Tebere Irrigation Scheme.

Whereas both motorised and non-motorised means of transport are used in the study area, the later plays a significant role, irrespective of restrictions on rearing livestock in the Scheme. There is therefore, a need to review the Irrigation Act to cater for the current developments and transport needs by farmers in Mwea Tebere Irrigation Scheme.
6.1 Introduction

This chapter presents findings on the assessment of the severity of transport constraints, their effects on farming and farmers' strategies in dealing with these constraints in Mwea Tebere Irrigation Scheme. The following research questions are answered:

(a) What pattern emerges from the farmers' rating of severity of the transport constraints they face and what are the reported effects of these transport constraints on farming?

(b) What efforts have the farmers made to overcome the transport constraints they face?

The null hypothesis (H0) tested is: There is no discernible pattern in the rating of transport constraints experienced by farmers in Mwea Tebere Irrigation Scheme.

6.2 Farmers' Assessment of the Severity of Transport Constraints and their Effects on Farming

A list of transport constraints was generated from extensive literature review and a pilot study. This list was presented to the respondents who were asked
to rate each constraint once on a qualitative scale consisting of the level: very serious, serious and not serious (Table 6.1).

Table 6.1: Rating of Transport Constraints by Respondents

<table>
<thead>
<tr>
<th>Transport constraints</th>
<th>Very serious Frequency</th>
<th>%</th>
<th>Serious Frequency</th>
<th>%</th>
<th>Not serious Frequency</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muddy routes</td>
<td>73</td>
<td>89.0</td>
<td>5</td>
<td>6.1</td>
<td>4</td>
<td>4.9</td>
</tr>
<tr>
<td>High transport charges by motor vehicle operators</td>
<td>63</td>
<td>78.9</td>
<td>7</td>
<td>8.5</td>
<td>12</td>
<td>14.6</td>
</tr>
<tr>
<td>Potholes on roads</td>
<td>23</td>
<td>28.0</td>
<td>49</td>
<td>59.8</td>
<td>10</td>
<td>12.2</td>
</tr>
<tr>
<td>Overgrown paths</td>
<td>29</td>
<td>35.4</td>
<td>36</td>
<td>43.9</td>
<td>17</td>
<td>20.7</td>
</tr>
<tr>
<td>Insecurity</td>
<td>34</td>
<td>41.5</td>
<td>15</td>
<td>18.3</td>
<td>33</td>
<td>40.2</td>
</tr>
<tr>
<td>Low number of motor vehicles</td>
<td>33</td>
<td>40.2</td>
<td>13</td>
<td>15.9</td>
<td>36</td>
<td>43.9</td>
</tr>
<tr>
<td>Long distances to markets and agro-shops</td>
<td>26</td>
<td>31.7</td>
<td>16</td>
<td>19.5</td>
<td>40</td>
<td>48.8</td>
</tr>
<tr>
<td>Long waiting time for motor vehicles</td>
<td>22</td>
<td>26.8</td>
<td>4</td>
<td>4.9</td>
<td>56</td>
<td>68.3</td>
</tr>
<tr>
<td>Refusal by motor vehicle operators to carry loads</td>
<td>8</td>
<td>9.8</td>
<td>6</td>
<td>7.3</td>
<td>68</td>
<td>82.9</td>
</tr>
<tr>
<td>Strict control of the use of motor vehicles in the Scheme by the National Irrigation Board</td>
<td>6</td>
<td>7.3</td>
<td>8</td>
<td>9.8</td>
<td>68</td>
<td>82.9</td>
</tr>
<tr>
<td>Low ownership of non-motorised means of transport</td>
<td>4</td>
<td>4.9</td>
<td>2</td>
<td>2.5</td>
<td>76</td>
<td>92.7</td>
</tr>
<tr>
<td>Fewer roads</td>
<td>2</td>
<td>2.4</td>
<td>4</td>
<td>4.9</td>
<td>76</td>
<td>92.7</td>
</tr>
</tbody>
</table>

Source: Field data (1999)

The problem of muddy routes had the highest rating (89%) on the scale of very serious. Muddy routes pose a problem of inaccessibility in Mwea Tebere Irrigation Scheme. The routes serving the Scheme, as already discussed in chapter four, are mainly footpaths and gravel-surfaced roads. A substantial proportion of the Scheme is covered by clay soils that have fine particles. During rainy seasons, these soils become sticky and slippery, making routes impassable. The transport situation during dry seasons is not easy either, especially for those walking, cycling or using animal-drawn carts. A discussion with the respondents revealed that the unpaved roads become very dusty as the fine particles of clay soils become loose. The problem of impassable and dusty roads is not unique to Mwea Tebere Irrigation Scheme,
as it has been identified in other rural areas of Tanzania (Kamulali, 1977; Chiteji, 1980) and Kenya (Khayesi, 1990; Odero, 1997).

Inaccessibility hinders on time delivery of inputs and produce. Consequently, rotting of farm produce especially tomatoes and French beans is a common phenomenon. In addition, farm activities such as planting that usually take place as soon as rains begin are delayed and this lead to low yields. During rainy seasons, transport of commodities is postponed until roads become passable. The problem is more pronounced when large volumes of goods have to be transported and when animal transport has to be relied on. Respondents pointed out that donkeys become ‘stubborn’ and usually refuse to wade through mud. This means that alternative means of transport, mostly human porterage which is less efficient, are used. Wachira and Munene (2000) report that farmers growing French beans in Mwea Tebere Irrigation Scheme sold their crops at different prices depending on their location in relation to the all-weather road. Those in close proximity sold at Kshs. 60 per three kilogrammes while those in remote areas sold three kilogrammes at Kshs. 20.

The effects of inaccessibility on farming have also been reported in other rural areas of Kenya (Ombiu, Arimi, McDermott, Mbugua, Kakuko and Kilungo, 1995; Odero, 1997; Shaw, 2000). Shaw (2000) reports that poor trunk and rural access roads increase costs of production and hamper transport of key commodities. He points out that: “transporting fertiliser from Mombasa to a Kenyan agricultural hinterland such as Kitale doubles its price” (Shaw, 2000:5). Ombiu, Arimi, McDermott, Mbugua, Kakuko and Kilungo (1995) found out that poor roads and vehicle maintenance caused delays in milk collection leading to milk spoilage in
Kiambu District. It is therefore necessary to improve the classified and unclassified road system.

High transport charges by motor vehicle operators was the second highly (79%) rated on the scale of very serious. The respondents pointed out that they could not always afford the fare as it is relatively high. They therefore use bicycles due to their availability and affordability. Every household interviewed in the current study owned a bicycle. The use of the bicycle by household members is termed free though there are purchase and maintenance costs. Bicycles used for hire are also readily available. On many occasions, the charges by bicycle operators are usually lower than charges by motor vehicle operators. There are, however, some occasions when the charges are the same. In spite of this, those who use hired bicycles prefer them to motor vehicles due to the flexibility of bicycle operators. Bicycle operators take their customer up to door-steps, a service public motor vehicle operators rarely offer.

The problem of insecurity was third in the rating (41.5%) on the scale of very serious. Respondents reported that it is not safe to travel alone, especially at night because one risks being attacked. A discussion with respondents revealed that some farmers have already lost their bicycles to thieves after being attacked in the late evenings. It is important to note that insecurity is a major and fast growing problem not only in the study area but also in Kenya at large (Daily Nation, 2001).

The constraint of inadequate motor vehicles was the fourth (40.2%) on the scale of very serious. Although the Embu-Nairobi paved road passes through the
Scheme, there are some parts of the Scheme such as Karaba that are located far from this all-weather road. Karaba is connected to this paved road by a gravel surfaced feeder road. Motor vehicles plying this road are not as many as those plying the paved road. Respondents reported that motor vehicles, however, increase during market days. Also some villages in Tebere section are located more than 6 kms from the Embu-Nairobi paved road. In fact, the commonly seen motor vehicles in the interior parts of the Tebere section are pick-ups and company lorries used by itinerant traders to collect farm produce.

Inadequate supply of transport services often resulted into other problems such as theft of crop and corruption. Respondents reported that although the tender winner for transportation of rice was supposed to supply adequate vehicles for transport, in most cases, he or she did not supply enough vehicles to meet the farmers’ demand. Consequently, some farmers who were financially capable reported that they bribed the drivers to collect their rice first. Those without money or who did not want to involve themselves in corruption spent several days and nights in the paddy fields awaiting transport. This is very stressful and can cause health problems, especially when it rains. Respondents stated that they experienced a number of problems during the paddy harvest season during the 1997/98-crop year. This was during the El-Niño rains [torrential rainfall associated with a weather phenomenon that involves an anomalous warming of the central and eastern equatorial Pacific Ocean (UNEP, 1992; Usher, 1998)] as motor vehicles would hardly reach the paddy fields due to muddy roads. Thus, farmers had to stay in the fields until the crop was transported to guarantee its security. It is important to point out here that the effects of 1997/98 El-Niño rainfall on transport in Kenya have been systematically analysed by Kayi (2002).
Contrary to the researcher’s expectation, fewer roads, low ownership of non-motorised means of transport, refusal by motor vehicle operators to carry loads and strict control of the use of motor vehicles in the Scheme by the National Irrigation Board were not considered serious problems by farmers (Table 6.1). These transport constraints reduce the connectivity of rural areas in Kenya (Kaira, 1983; Khayesi, 1990, 1993; Nalo, 1994; Kenya, 1997c; Odero, 1997). This finding in relation to Mwea Tebere Irrigation Scheme could indicate the farmers’ ability in devising coping strategies.

Before discussing the coping strategies used by farmers in Mwea Tebere Irrigation Scheme, it was found necessary to determine whether or not there exists any pattern of association among the twelve qualitatively rated variables. To do this, factor analysis was employed. It was used to classify the twelve variables into groups of related factors and determine if the groups of variables identified were statistically significant.

### 6.3 Factor Analysis of the Transport Constraints

The first stage in factor analysis involved the computation of correlation coefficients among the twelve variables. Although the correlation matrix presented in Table 6.2 generally shows low correlations, important relationships are evident. For example, there is a positive correlation between high transport cost and muddy routes ($r = 0.18068$). Long distances to markets and agro-shops also have a positive correlation with high transport charges by motor vehicles ($r = 0.30950$). This means that poor routes serving the scheme lead to high transport
Table 6.2: Product-moment Correlation Matrix among Variables (Transport Constraints) Faced by Farmers

<table>
<thead>
<tr>
<th></th>
<th>V01</th>
<th>V02</th>
<th>V03</th>
<th>V04</th>
<th>V05</th>
<th>V06</th>
<th>V07</th>
<th>V08</th>
<th>V09</th>
<th>V10</th>
<th>V11</th>
<th>V12</th>
</tr>
</thead>
<tbody>
<tr>
<td>V01</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V02</td>
<td>0.18068</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V03</td>
<td>0.03791</td>
<td>-0.04085</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V04</td>
<td>-0.04427</td>
<td>0.11844</td>
<td>-0.18740</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V05</td>
<td>-0.04370</td>
<td>0.30950</td>
<td>-0.06632</td>
<td>0.01369</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V06</td>
<td>-0.07119</td>
<td>0.04006</td>
<td>0.09576</td>
<td>-0.05453</td>
<td>0.00998</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V07</td>
<td>0.14266</td>
<td>0.18724</td>
<td>-0.18301</td>
<td>-0.06041</td>
<td>0.34870</td>
<td>-0.08018</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V08</td>
<td>0.03511</td>
<td>-0.10073</td>
<td>0.06572</td>
<td>-0.00766</td>
<td>0.07632</td>
<td>0.26192</td>
<td>0.04725</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V09</td>
<td>-0.00233</td>
<td>0.07528</td>
<td>0.00252</td>
<td>0.14662</td>
<td>0.05003</td>
<td>0.30480</td>
<td>0.07972</td>
<td>0.32698</td>
<td>1.0000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V10</td>
<td>0.15490</td>
<td>0.20733</td>
<td>-0.01122</td>
<td>0.04919</td>
<td>-0.09105</td>
<td>0.19919</td>
<td>0.20142</td>
<td>-0.01927</td>
<td>0.09874</td>
<td>1.0000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V11</td>
<td>-0.45343</td>
<td>-0.10689</td>
<td>-0.02326</td>
<td>-0.07110</td>
<td>-0.10078</td>
<td>0.07317</td>
<td>-0.02943</td>
<td>-0.12711</td>
<td>-0.06958</td>
<td>0.06554</td>
<td>1.0000</td>
<td></td>
</tr>
<tr>
<td>V12</td>
<td>0.13702</td>
<td>-0.01418</td>
<td>0.06060</td>
<td>-0.11299</td>
<td>-0.25781</td>
<td>-0.16995</td>
<td>-0.04892</td>
<td>-0.07616</td>
<td>-0.09135</td>
<td>0.29674</td>
<td>-0.06329</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

Source: Field data (1999)

**Variables**
- V01 (Muddy roads)
- V02 (High transport charges by motor vehicle operators)
- V03 (Low number of motor vehicles)
- V04 (Fewer roads)
- V05 (Long distances to markets and agro-shops)
- V06 (Strict control of the use of motor vehicles in the scheme by the National Irrigation Board)
- V07 (Refusal by motor vehicle operators to carry loads)
- V08 (Overgrown paths)
- V09 (Potholes on roads)
- V10 (Long waiting time for motor vehicles)
- V11 (Low ownership of non-motorised means of transport)
- V12 (Insecurity)
cost and long distances travelled to the markets and agro-shops.

The next stage in the analysis was to extract factors. This was done by the rotation of simple correlation matrix in order to place the factor in a position in which variables with high correlations on it could be isolated. The factor matrix containing loadings between each variable and the new factor was derived (Table 6.3). The loadings give the ordinary correlation coefficients between a variable and a factor (Dillon and Goldstein, 1984). By comparing the factor loadings for all factors and all variables, those variables that are most related to a factor can be identified.

Table 6.3 shows that low numbers of motor vehicles, long distances to markets and agro-shops and refusal by motor vehicle operators to carry loads have moderate positive loadings on factor 1 while all the other variables have low loadings. For factor 2, high transport charges by motor vehicle operators and insecurity load moderately positively on it. Strict control of the use of motor vehicles in the Scheme by National Irrigation Board has a moderately negative loading on factor 2. All the other variables have low loadings on this factor. Only one variable, long distance to markets and agro-shops, loads moderately positive on factor 3. The other variables have low loadings on it.

There are two variables, long waiting time for motor vehicles and low ownership of non-motorised means of transport that load moderately positively on Factor 4. The other variables have low loadings on it. For factor 5, only one variable, fewer roads, has a moderate loading on it while the other variables have low loadings. For factor 6, low number of motor vehicles loads moderately positively and the
other variables have low loadings on it. From this analysis, six factors are extracted and the composition of factors in the matrix shown. It is, however, not possible to make a decision as to which factors are significant from this factor matrix.

In order to decide which factors are significant and thus retain them for further description and analysis, varimax rotation was done. Varimax rotation aims at maximising the variance by deriving loadings as closer to +1.0 or -1.0 as possible. Results of the varimax rotation are shown in Table 6.4. The six factors are deemed significant because each has an eigenvalue of 1.0 and above. An eigenvalue of 1.0 or more is considered to indicate that a particular factor explains a significant proportion of the total variance than does a single variable observed in the field (Johnston, 1980; Dillon and Goldstein, 1984).

In addition, the six factors have an accumulative tracer percentage of 71.4, meaning that they have a high degree of explanation of the total variation in the data set.

Table 6.3: Unrotated Factor Structure Matrix

<table>
<thead>
<tr>
<th>Variables</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
<th>Factor 5</th>
<th>Factor 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>V01</td>
<td>-0.11985</td>
<td>0.08219</td>
<td>0.39254</td>
<td>-0.26283</td>
<td>0.49663</td>
<td>0.48812</td>
</tr>
<tr>
<td>V02</td>
<td>0.40776</td>
<td>-0.55464</td>
<td>0.31479</td>
<td>-0.34236</td>
<td>-0.04406</td>
<td>-0.01393</td>
</tr>
<tr>
<td>V03</td>
<td>0.57499</td>
<td>-0.24407</td>
<td>-0.18760</td>
<td>0.22178</td>
<td>0.05980</td>
<td>0.51304</td>
</tr>
<tr>
<td>V04</td>
<td>0.18793</td>
<td>0.07707</td>
<td>-0.18668</td>
<td>0.10810</td>
<td>-0.78772</td>
<td>0.26621</td>
</tr>
<tr>
<td>V05</td>
<td>0.54006</td>
<td>0.11915</td>
<td>-0.52580</td>
<td>-0.11763</td>
<td>0.35347</td>
<td>0.10377</td>
</tr>
<tr>
<td>V06</td>
<td>0.26614</td>
<td>0.56670</td>
<td>0.41224</td>
<td>0.20746</td>
<td>0.12431</td>
<td>0.18267</td>
</tr>
<tr>
<td>V07</td>
<td>0.55827</td>
<td>-0.18513</td>
<td>-0.30310</td>
<td>0.21826</td>
<td>0.28394</td>
<td>-0.47558</td>
</tr>
<tr>
<td>V08</td>
<td>0.34595</td>
<td>0.46683</td>
<td>0.36648</td>
<td>-0.27018</td>
<td>-0.00195</td>
<td>-0.36372</td>
</tr>
<tr>
<td>V09</td>
<td>0.47552</td>
<td>0.46428</td>
<td>0.31278</td>
<td>0.05763</td>
<td>-0.23331</td>
<td>-0.07707</td>
</tr>
<tr>
<td>V010</td>
<td>0.31724</td>
<td>-0.25757</td>
<td>0.41445</td>
<td>0.66714</td>
<td>0.02696</td>
<td>0.02515</td>
</tr>
<tr>
<td>V011</td>
<td>-0.41045</td>
<td>0.34447</td>
<td>-0.18597</td>
<td>0.63261</td>
<td>0.21051</td>
<td>-0.02936</td>
</tr>
<tr>
<td>V012</td>
<td>-0.16484</td>
<td>-0.55130</td>
<td>0.47460</td>
<td>0.23985</td>
<td>0.01142</td>
<td>-0.13622</td>
</tr>
</tbody>
</table>

Source: Field data (1999)
Table 6.4: Varimax Rotated Factor Matrix

<table>
<thead>
<tr>
<th>Variables</th>
<th>Factor 1</th>
<th>Factor 2</th>
<th>Factor 3</th>
<th>Factor 4</th>
<th>Factor 5</th>
<th>Factor 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>V01 (Muddy roads)</td>
<td>0.10691</td>
<td>0.09211</td>
<td>-0.03669</td>
<td>-0.45989</td>
<td>0.20191</td>
<td>0.67503</td>
</tr>
<tr>
<td>V02 (High transport charges by motor vehicle operators)</td>
<td>-0.02229</td>
<td>0.77881</td>
<td>0.24373</td>
<td>0.08754</td>
<td>0.11576</td>
<td>0.06945</td>
</tr>
<tr>
<td>V03 (Low number of motor vehicles)</td>
<td>-0.01408</td>
<td>0.14164</td>
<td>0.05780</td>
<td>0.11911</td>
<td>0.83345</td>
<td>-0.09438</td>
</tr>
<tr>
<td>V04 (Fewer roads)</td>
<td>0.08669</td>
<td>0.05309</td>
<td>-0.08079</td>
<td>-0.23100</td>
<td>0.22437</td>
<td>-0.81153</td>
</tr>
<tr>
<td>V05 (Long distances to markets and agro-shops)</td>
<td>0.04675</td>
<td>0.03657</td>
<td>-0.50152</td>
<td>0.46901</td>
<td>0.49067</td>
<td>0.12686</td>
</tr>
<tr>
<td>V06 (Strict control of the use of motor vehicles in the scheme by the National Irrigation Board)</td>
<td>0.71654</td>
<td>-0.22422</td>
<td>0.06540</td>
<td>-0.15429</td>
<td>0.18768</td>
<td>0.16366</td>
</tr>
<tr>
<td>V07 (Refusal by motor vehicle operators to carry loads)</td>
<td>0.03322</td>
<td>0.05822</td>
<td>0.05604</td>
<td>0.87158</td>
<td>0.15774</td>
<td>0.01832</td>
</tr>
<tr>
<td>V08 (Overgrown paths)</td>
<td>0.70378</td>
<td>0.20620</td>
<td>-0.13979</td>
<td>0.14581</td>
<td>-0.30042</td>
<td>0.09129</td>
</tr>
<tr>
<td>V09 (Potholes on roads)</td>
<td>0.74346</td>
<td>0.06121</td>
<td>0.00373</td>
<td>0.04119</td>
<td>0.04539</td>
<td>-0.20724</td>
</tr>
<tr>
<td>V10 (Long waiting time for motor vehicles)</td>
<td>0.21963</td>
<td>-0.07720</td>
<td>0.76978</td>
<td>0.16444</td>
<td>-0.33158</td>
<td>-0.03797</td>
</tr>
<tr>
<td>V11 (Low ownership of non-motorised means of transport)</td>
<td>-0.05245</td>
<td>-0.86406</td>
<td>0.11050</td>
<td>0.03004</td>
<td>-0.03630</td>
<td>0.05754</td>
</tr>
<tr>
<td>V12 (Insecurity)</td>
<td>-0.19613</td>
<td>0.17752</td>
<td>0.72606</td>
<td>-0.04283</td>
<td>-0.14305</td>
<td>0.11454</td>
</tr>
<tr>
<td>Eigenvalues</td>
<td>1.86281</td>
<td>1.67193</td>
<td>1.52523</td>
<td>1.33106</td>
<td>1.19328</td>
<td>1.00112</td>
</tr>
<tr>
<td>Tracer Percentage</td>
<td>15.5</td>
<td>13.9</td>
<td>12.7</td>
<td>11.1</td>
<td>9.9</td>
<td>8.3</td>
</tr>
</tbody>
</table>

Source: Field data (1999)
Another method used to select significant factors explaining the transport constraints is the scree-slope technique. The scree-slope approach is based on identifying a distinctive break-off in the slope in the plot of factors. This break is clearly identified at the fifth factor level (Fig.6.1). The break in the slope at the fifth factor is abrupt and the cut-off point is thus at the fifth factor. Although other factors after the fifth are non-significant, factor six is considered significant as it has an eigenvalue of 1.0 (Table 6.4). It is therefore retained for further description and analysis.

![Scree Slope Graph](https://via.placeholder.com/150)

**Figure 6.1: Scree Slope Graph**

*Source: Field data (1999)*

The next stage was to label and describe the selected significant factors to facilitate interpretation of the findings. Labelling of the factors is based on variables that load highly either positively or negatively on each factor. Loadings ranging from ±1.0 to ±0.70 are categorised as high, those ranging
from ±0.69 to ±0.50 as moderate and those ranging from ±0.49 to ±0.30 as low.

Variables that have moderate positive correlation with factor 1 are: strict control of the use of motor vehicles in the Scheme by the National Irrigation Board (0.6588), overgrown paths (0.6743) and potholes on roads (0.5994). Evidently, these variables relate to the management and operations of the Scheme. Factor 1 is, therefore, labelled Administrative and Management Constraints.

The importance of this factor is revealed in its tracer percentage of 15.5 %. This factor accounts for a greater proportion of the total variance. It can thus be concluded that administrative and management constraints significantly contribute to the generation of transport constraints in Mwea Tebere Irrigation Scheme. The Government, through the National Irrigation Board, permits or controls the movement of motor vehicles within the Scheme. Hence, to operate a motor vehicle in the Scheme, one has to acquire a permit from the National Irrigation Board manager. Respondents pointed out that it is the duty of the Board to maintain the roads within the Scheme. Thus, the presence of potholes on roads and overgrown footpaths reveal the Board’s inefficiency in road maintenance.

High transport charges by motor vehicle operators has a moderate positive correlation coefficient (0.6938) with factor 2 while low ownership of non-motorised means of transport has a high negative correlation coefficient (-0.8640) with it. These variables are related to financial ability of the
respondent. Factor 2 is therefore given the label, **Financial Constraints**. The importance of factor 2 is revealed in its tracer percentage of 13.9% meaning that this factor accounts for 13.9% of the total variance accounted for by the 12 variables.

Most households use non-motorised means of transport including bicycles, walking or human porterage, ox- and donkey-drawn carts and rarely use motor vehicles. Motor vehicle operators charge highly for the services they offer and farmers lack adequate funds to pay for the services. Farmers mainly depend on income from the sale of crops which varies with crop season. The cost of buying a motor vehicle is also high compared to that of non-motorised means of transport. Indeed, whereas the interviewed households own at least a bicycle, none of them owns a motor vehicle. It can therefore be concluded that lack of money compounds transport problems, leading to reliance on walking and human porterage in the study area.

Long waiting time for motor vehicles and insecurity have high positive correlation coefficients of 0.7698 and 0.7261, respectively with factor 3. These variables relate to accessibility and therefore factor 3 is named **Inaccessibility**. This factor has a tracer percentage of 12.7% implying that 12.7% of the total variance of the 12 variables is accounted for by factor 3.

Only one variable, refusal by motor vehicle operators to carry loads has a high positive correlation coefficient of 0.8716 with factor 4. This variable relates to provision of transport service and thus the label **Load Transport Constraints**. This factor has a tracer percentage of 11.1% meaning that out
of the total variance of the 12 variables 11.1% is accounted for by the fourth factor.

Although some households and markets in Mwea Tebere Irrigation Scheme are along the tarmac roads, which have a high fleet of motor vehicles, the motor vehicle operators rarely carry passengers whose trips involve transportation of loads particularly, the bulky ones. Furthermore, when public motor vehicles carry such loads, farmers have to pay for the load depending on their weight. These findings concur with those of Porter (1998) that farmers in Ghana were often by-passed by motor vehicles because of the load sizes accompanying their trips.

Low number of motor vehicles has a high positive correlation coefficient (0.8335) with factor 5. This variable relates to the availability of motorised means of transport. This factor is given the name **Inadequate Motor Vehicle Services**. Factor 5 accounts for 9.9% of the total variance of the 12 original variables.

Apart from a few households located in close proximity to all weather roads in the Scheme, most households are located far from the tarmac roads. Only a few motor vehicles offer transport services to the interior parts of the Scheme. Hence, farmers located in such places do not have easy access to motor vehicles. In addition, even when the National Irrigation Board tenders transport services in the Scheme, the tender winners do not supply enough motor vehicles to meet the demand for farmers (Chapter 5).
Muddy routes have moderate positive correlation coefficient (0.6750) with factor 6 while fewer roads have high negative correlation coefficient (-0.8115) with it. These variables relate to the nature of roads. Factor 6 is given the label **Poor Road Infrastructure**. Factor 6 accounts for 8.3% of the total variance of the original variables. As already discussed in Chapter 4, the study area is served by footpaths and gravel surfaced roads. These roads become impassable during rainy seasons. This problem is compounded by the fact that most parts of the study area are covered by clay soil which become sticky and muddy even with light rain showers.

The tracer percentage derived from factor analysis is 71.4%. This indicates that 71.4% of the total variance of the 12 original variables is accounted for by the six factors. Therefore, the factor analysis reveals a pattern in the rating of the transport constraints experienced by farmers in Mwea Tebere Irrigation Scheme. Thus, the null hypothesis: there is no discernible pattern in the rating of transport constraints experienced by farmers in Mwea Tebere Irrigation Scheme is rejected.

### 6.4 Strategies Used by Farmers to Overcome the Transport Constraints

In an attempt to overcome the transport constraints related to high transport cost, long distances to markets and agro-shops and low number of motor vehicles, farmers in Mwea Tebere Irrigation Scheme use non-motorised means of transport such as bicycles, donkey- and ox-drawn carts. The respondents reported that the affordability and low maintenance costs of these means of transport as compared to motor vehicles enhanced their
widespread use. All households owned at least one of these means of transport.

Besides being used for relatively shorter distances, the bicycle is also used for long-distances travel, especially in cases where the journey involves personal travel and/or transport of light loads. In fact, some respondents reported that they used the bicycle to cover trip lengths of about 40 kms.

Animal-drawn carts are particularly important during rainy seasons when roads become impassable. Oxen and donkeys are hardy animals that wade through mud. Farmers who do not own any of these animals hire them for transport. They are preferred to motor vehicles because the animal transport operators offer door-to-door transport services.

Another strategy utilised by farmers is to undertake few and multi-purpose visits to the market. The respondents reported that they reduced the number of times they went to the market. Many of the respondents visited the market only during market days when motor vehicle operators offering transport services to regions located far from the market increase. During such visits, various purposes are achieved including selling farm outputs, buying farm inputs and other domestic necessities and meeting friends.

6.5 Summary

A discussion on transport constraints, their effects on farming and farmers' strategies in overcoming these constraints has been presented in this chapter.
Respondents were presented with 12 variables related to transport constraints and asked to rank them. The constraint of muddy routes was highly ranked on the scale of very serious, followed by high transport charges by motor vehicle operators, insecurity and inadequate motor vehicles in that order. Fewer roads, low ownership of non-motorised means of transport, strict control of use of motor vehicles in the scheme by the National Irrigation Board and refusal by motor vehicle operators to carry loads were considered not to be serious. To determine whether or not there was a clear structure of transport constraints affecting farmers in the study area, the data were subjected to factor analysis.

With the use of factor analysis, the 12 variables were reduced to six important factors. The factors were identified as: administrative and management constraint; financial constraints; inaccessibility; load transport constraints; poor road infrastructure and inadequate motor vehicle services. The results of factor analysis indicate a clear pattern in the rating of transport constraints by farmers in Mwea Tebere Irrigation Scheme with 71.4 per cent of the total variance of the 12 original variables being accounted for by the six factors. Hence, the null hypothesis: there is no discernible pattern in the rating of transport constraints experienced by farmers in Mwea Tebere Irrigation Scheme is rejected.

The main effect of transport constraints on farming is delay in undertaking farming activities which lead to low production. The findings presented in this chapter reveal that the transport needs in Mwea Tebere Irrigation Scheme are not adequately met. As a result, farmers have come up with strategies
such as use of non-motorised means of transport, restricting the number of times they visit the market and making such visits multi-purpose. Of these strategies, the use of non-motorised means of transport is widely applied.
CHAPTER 7

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 Introduction

This study has analysed farming related transport needs and provision in Mwea Tebere Irrigation Scheme in Kirinyaga District, Kenya. Specifically, the following aspects have been examined: (a) the basic features of farming related movement, (b) organisation and provision of transport, (c) farmers’ assessment of the transport constraints they face and the effects of these constraints on farming, and (d) farmers’ efforts in overcoming the transport constraints. A summary of the main findings of this study, conclusions and recommendations are presented in this chapter.

7.2 Summary of the Main Findings

The average distance travelled daily by an individual farmer is 2.3 kms. Overall, the trip length goes up to 4 kms. Beyond 4 kms, the number of trips decreases and more men than women are involved in such trips. The distances travelled daily, however, vary from one site of the Scheme to another. A statistical analysis of this variation using ANOVA found it to be significant. This variation is partly explained with respect to farming activities taking place in each location at the time of data collection and partly to their location from the markets and the Embu-Nairobi tarmac road.
The distances travelled between the homesteads and the farms in Mwea Tebere Irrigation Scheme are relatively short, with most trip lengths going up to 3 kilometres. Distances travelled daily vary by means of transport used. Walking dominates short trips of up to 1 km while bicycle and motor vehicle dominate long distances.

The average amount of time spent daily by all respondents on all types of movement is 1 hour and 52 minutes. Sixty seven per cent of this time is spent on farming related movement. A student’s t-test reveals that men spend more time than women do on farming-related movement.

Footpaths and gravel roads are the commonly used routes in Mwea Tebere Irrigation Scheme. Most farm-level movements are confined within a farmer’s locality and only a few trips take the trip maker beyond his or her village. Many trips aimed at accomplishing farming activities are on foot, by bicycle and ox- and/or donkey-drawn carts. Farming related trips involved the transport of light loads such as *jembes*, pesticides, water pumps and French beans.

Whereas both men and women accomplish their journeys on foot, by bicycle or motor vehicle, a chi-square test demonstrated that there is a significant difference between the means used by men and women. Men mainly use bicycles for most of their trips while women walk. The limited use of the bicycle by women is attributed to cultural beliefs and attitudes and the fact that women could only use the bicycles as long as the male members of the household were not using them.
Different means of transport are used to transport crops in the Scheme from the farm to markets, stores or homesteads. Human porterage is commonly used for the transport of French beans to the "shade". Middlemen, using pick-ups or lorries, provided transport for tomatoes to the markets. Ox- and /or donkey-drawn carts are used for transport of maize and beans while animal-drawn carts, lorries and tractors are used in transportation of rice.

A number of agents are involved in the provision of transport service to farmers in Mwea Tebere Irrigation Scheme. This results in situation in which there are varying arrangements to cater for transport of agricultural produce. The agents include the public sector through the National Irrigation Board and the private sector through farmers' cooperative society, individual farmers and itinerant traders.

Farmers experience a number of transport constraints of which they rated the following as very serious: muddy routes, high transport charges by motor vehicle operators, insecurity and low number of motor vehicles. Using factor analysis, the 12 variables (transport constraints) rated by farmers were reduced to six important factors, namely, administrative and management constraints, financial constraints, inaccessibility, load transport constraints, poor road infrastructure and inadequate motor vehicle services. The results of factor analysis demonstrate that there is a discernible pattern in the rating of transport constraints by farmers in Mwea Tebere Irrigation Scheme.

The main effect of the transport constraints on farming is delay in on-time performance of farm activities. In an attempt to overcome the transport
constraints facing them, farmers utilised the following strategies: use of non-motorised means of transport, reducing the number of trips to the market and making such trips multipurpose.

7.3 Conclusions

The findings of this research indicate that the existence of an all-weather road in Mwea Tebere Irrigation Scheme does not necessarily relieve the transport burden borne by the farmers. Most of the farming related transport needs are met using non-motorised means of transport including bicycles, human porterage and animal-drawn carts. These means of transport mainly ply on footpaths and gravel surfaced roads and are more efficient in transporting small loads over relatively short distances. While paved roads are important in the movement of people and goods beyond the Scheme to other regions, there is the local level transport system, which link rural communities and villages to such roads. The linkage is in terms of:

(i) transporting agricultural produce to the roadside where motor vehicles can transport it to the urban areas,

(ii) transporting agricultural produce to the nearer market centres where some may be consumed and the rest is taken to the bigger urban areas and

(iii) transporting goods found within the market centres, for example, fertilisers and farm implements to the hinterlands.

It is therefore concluded that the use of both motorised and non-motorised means of transport in Mwea Tebere Irrigation Scheme play complementary
roles in meeting the transport needs of farmers and should be promoted. Footpaths and gravel-surfaced roads should be upgraded as they play an important role as links at the farm-level. The National Irrigation Board as the central organisation looking into the development of the scheme should give the promotion and upgrading of effective means and modes of transport the attention they deserve.

7.4 Recommendations

The findings of this study show that short daily return trips often involving transportation of small load sizes, characterise farming related movement in Mwea Tebere Irrigation Scheme. Short trips and transportation of small quantities of commodities do not warrant exclusive use of motor vehicles. The use of motor vehicles to transport such small loads over short distances is uneconomical to the farmers. It is thus recommended here that the use of non-motorised means of transport, especially those already in use (ox- and donkey-drawn carts and bicycles) in Mwea Tebere Irrigation Scheme, should be promoted. For example, the load-carrying capacity of the bicycle, which is already an important means of transport in the study area, needs to be increased. This can be through attaching a trailer to the rear of the bicycle. The trailer allows heavier and more voluminous loads to be moved by bicycle on flat terrain (Barwell, 1996). Such a measure would go far in improving the farming related transport service provision in the study area as it has a flat terrain. In addition, the prices of bicycles should be subsidised to enable more farmers to buy them.
To fully encourage the use of animal transport in the study area, the policy governing the rearing of livestock in the Scheme need to be reviewed. Currently a farmer is restricted as to the number of livestock he or she should have at a time (Kenya, 1986b). This limits the use of animal transport in Mwea Tebere Irrigation Scheme.

Both motorised and non-motorised means of transport used in the Scheme move on roads of different nature. Footpaths, gravel surfaced and tarmac roads are used. It has been shown in this study that most of the farming-related movements take place on footpaths and gravel surfaced roads. The farmers identified muddy roads, overgrown paths and potholes on roads as some of the serious transport problems facing them. This implies lack of road maintenance in the Scheme. Poor or lack of road maintenance hinders easy movement, raises transport costs (monetary and time), causes breakdown of means used on them and is closely associated with insecurity in the area. Improvement of all the roads in the Scheme could be a very efficient measure to stimulate agricultural production in Mwea Tebere Irrigation Scheme. Once roads are improved, more transport agents will be willing to provide transport services, thereby widening the choices a farmer has. Consequently, the increase in transport cost may be checked. It is therefore recommended that both the government and the local community get involved in construction, repair and maintenance of roads in Mwea Tebere Irrigation Scheme.

At the time the fieldwork for this study was conducted, farmers felt that it was not their duty to maintain the roads. They attributed the work of road construction and maintenance entirely to the government through the
National Irrigation Board. The farmers in the Scheme are tenants and have no title deeds for the pieces of land they cultivate. This has made farmers to have an attitude that it is not their responsibility to take care of what they refer to as "Government roads". It is thus recommended here that the Government should motivate farmers to take up the responsibility of road maintenance. This can be achieved through issuing farmers with title deeds hence, legal ownership of land. This calls for the need to review the parts of irrigation act that address the land tenure system in irrigation schemes. Another way farmers can be motivated to participate in road maintenance is paying them for the services they offer when they participate.

7.5 Suggestions for Further Research

The following are deemed to be appropriate areas for further research:

(a) This study was limited to Mwea Tebere Irrigation Scheme in Kirinyaga District, Kenya. It is recommended that a similar study should be conducted in the other irrigation schemes in Kenya. Other irrigation schemes may have different farming related transport needs as different crops from rice are produced. Some irrigation schemes, for example, Perkerra deal with horticultural crops such as onions and chillies. The crops produced influence the transport needs of a farmer. This implies that the recommendations outlined above may not be fully applicable in other irrigation schemes.

(b) This study was limited to transport activities between the farm, the house and the market. The transport activities at this level play a significant role in the broad economy. It is at the farm level that crops are produced and
for their production, various inputs are used. Inputs must get to the farm to be of use to the farmer while farm outputs must be distributed from the farm to the markets. The reality is that movement between the farm, and market is the beginning of a long chain of transactions. Hence, the need to study transport inputs-outputs in the entire crop production and distribution system. This would give a more comprehensive picture of transport as an input in agriculture.

(c) A study on ways of improving or promoting the intermediate means of transport used in Mwea Tebere Irrigation Scheme. Such a study would seek to examine the factors that hinder the development of these means and highlight methods of improving their utilisation.

(d) A follow-up study should be conducted in Mwea Tebere Irrigation Scheme. Currently, the scheme is going through changes due to the crisis related to rice marketing. Such a study should seek to find out how the restructuring in the institutional set up would affect transport service.
REFERENCES


APPENDICES

Appendix 1: Farm Survey Questionnaire

A. General Information

1. Date: -------------------------------

2. Interviewer: ---------------------

3. Respondent’s name (optional) ---------

4. Sex of respondent: Male (1) -------

Female (2) -------

5. Section: Karaba (1) ------ Tebere (2) ------ Thiba (3) ----

6. How many people live in this home? --------

B. Agriculture

1. What is the size of your farm in acres?

2. (a) Do you have farm plots outside the scheme? Yes (1) ---No (2) -

(b) If yes, how many are they? -------

(c) Indicate in the table below the location of the plot, distance from your house and means of transport you usually use to get to the farm.

<table>
<thead>
<tr>
<th>Location of plot</th>
<th>Distance in Kms</th>
<th>Means of transport used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
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</tr>
</tbody>
</table>

3. List the crops you grow on your farm and indicate the annual total amount harvested for each crop.
4. Are the crops listed in question 3 above for home consumption (1), marketing (2) or both (3)?

<table>
<thead>
<tr>
<th>Crops</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice</td>
<td></td>
</tr>
<tr>
<td>French beans</td>
<td></td>
</tr>
<tr>
<td>Tomatoes</td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td></td>
</tr>
<tr>
<td>Beans</td>
<td></td>
</tr>
</tbody>
</table>

5. What is the average income in Kshs earned from crop sale for the last season?

6. What means of transport do you usually use to transport your produce from the farm to the market, store or house?

<table>
<thead>
<tr>
<th>Crops</th>
<th>Destination</th>
<th>Means of transport</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tbody>
</table>

7. Indicate in the table below the inputs you usually use in the production of the following crops and the means of transport you mainly use to move them from the sources to your farm.

<table>
<thead>
<tr>
<th>Crops</th>
<th>Inputs</th>
<th>Means of transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>French beans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rice</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tomatoes</td>
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<tr>
<td>Beans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize</td>
<td></td>
<td></td>
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<tr>
<td>Others (specify)</td>
<td></td>
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</tr>
</tbody>
</table>
C. Transport Constraints and their Effects on Farming

8. The following are transport problems mainly experienced in rural areas. Study each one of them carefully and then rank each according to whether it is very serious, serious or not serious in your case.

<table>
<thead>
<tr>
<th>Transport Constraints</th>
<th>Very serious</th>
<th>Serious</th>
<th>Not serious</th>
</tr>
</thead>
<tbody>
<tr>
<td>High transport charges by motor vehicle operators</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low number of motor vehicles</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Muddy routes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fewer roads</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long distances to markets and agro-shops</td>
<td></td>
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<tr>
<td>Strict control of the use of motor vehicles in the scheme by the National Irrigation Board</td>
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<tr>
<td>Refusal by motor vehicle operators to carry loads</td>
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<td></td>
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<tr>
<td>Overgrown paths</td>
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<tr>
<td>Potholes on roads</td>
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<tr>
<td>Long waiting time for motor vehicles</td>
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<tr>
<td>Low ownership of non-motorised means of transport (e.g. animal carts, bicycles)</td>
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<tr>
<td>Insecurity</td>
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<td></td>
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<tr>
<td>Others (specify)</td>
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</tbody>
</table>

9. How do the transport problems outlined in (8) above affect your agricultural production?

10. In what ways have you tried to solve the transport problems that you face?

11. What have other farmers done?

12. How else in your opinion can the transport services to farmers be improved?
Appendix 2: Space-Time Movement Frequency Matrix of Household Members

Respondent: ----------------------------------- Sex --- Age ------- Date: -------------

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Origin</th>
<th>Destination</th>
<th>Means of transport</th>
<th>Provider</th>
<th>Distance covered in Kms</th>
<th>Transport cost in Kshs</th>
<th>Nature of route used</th>
<th>Goods carried</th>
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Appendix 3: Guide for Focus Group Discussion

1. The following are some of the agents involved in provision of agricultural transport services. Which of these agents provide transport services in the scheme?
   a. Middlemen
   b. Communal
   c. Cooperative society
   d. Individual
   e. Others (specify)

2. How efficient are the agents mentioned in (1) above?

3. What transport problems do you face as farmers in the scheme?

4. What have you done on your own to solve the problems?

5. What improvement would you like to see concerning transport in the scheme?