DEMAND FOR TRACTOR SERVICES IN TRANS-NZOIA DISTRICT

A research paper submitted to the Department of Economics, Kenyatta University, in partial fulfilment of the requirements for the degree of Masters of Arts in Economics

BY

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This Research paper is my original work and has not been presented for a degree in another University.

JEREMIAH ABOK OBILO

This Research paper has been submitted for examination with our approval as University Supervisors.

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D E D I C A T I O N

I would like to dedicate this piece of work to my father Meshack Abok Nyawuana for his foresight in education.

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I would like to express my sincere gratitudes to all those who taught and advised me during my graduate course.

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A B S T R A C T

The current study was formulated to investigate into the factors that affect the demand for tractor services among smallholders in Trans-Nzoia district. Questionnaire was used to collect data and about 113 small farm holders were interviewed.

Multiple regression analysis was then used to determine the association between the use of tractors and the various postulated independent variables. The empirical findings of the study indicate that there is a strong correlation between use of tractors and the following: land acreage, the tractor hire charges; though contrary to apriori expectations, empirical evidence of this study show apparently a weak relationship between income variations and the demand for tractor services. The researcher suggests that this might be a reflection of low income levels of small farm holders. Other variables like age of the farmer; education levels, and their main occupation were statistically insiginificant at the 5 per cent level.

The study also revealed several tractor services which small farm holders utilise. Among these, ploughing activity was the most used tractor service; and 92.5 per cent of the respondents had used tractors for ploughing during the period of data collection. Other tractor services which were identified were re-ploughing, harvesting, planting shelling and transport.

Finally, based on the statistical results various policy implications were suggested.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY:

1.1.1 Agriculture in the Kenyan Economy

It is not our objective to exhaustively analyse the importance of agriculture in the Kenyan economy as this has been done by several documents both by government[1] and individuals. Nevertheless, it is important to touch on some major contributions of agriculture to the economy. In Kenya, the agricultural sector has emerged as the most predominant sector in the economy (see table 1.1.1.1 below). Its relative size in the economy, both in terms of gross domestic product (GDP) and in terms of employment is an obvious dimension.

A comparison of the agricultural sector with the next best competing possibilities (for example manufacturing as far as its contribution to the GDP is concerned and community social and personal services sector on employment basis) demonstrates that the agricultural sector in Kenya has a vital role to play in the process of economic development. Infact the current Development Plan 1989/93 (P:103) indicates clearly that agriculture is the main stay of Kenya's economy.

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1 Refer to the following Government documents as far as the agricultural contribution to the Kenyan economy is concerned:-
a) Development Plan 1989 - 1993, Government printer, Nairobi Page 106-113

b) Sessional Paper No. 1 of 1986 on Economic Management for Renewed growth, Government printer, Nairobi PP 62-63.

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TABLE 1.1...1.1

Gross Domestic Product at Factor Cost in the Monetary economy as a percetage of Total GDP at constant 1982 prices and wage Employment by industry 1982 - 1988

INDUSTRY	1982	1983	1984	1985	1986	. 1988*
Agriculture & Forestry**	31.82(223,867)	31.93(231,068)	30.52(231,068	30.25(240,879)	29.95(248,455)	256,40
Fishing	0.28	0.36	0.36	0.36	0.39	na
Mining & Quarrying	0.23(3025)	0.22(3550)	0.24(4089)	0.24(4790)	0.23(5501)	(6400)
Manufacturing	12.75(146780)	12.82(148758)	13.24(153145)	13.25(158763)	13.67(164800)	(174800)
Electricity & Water	1.61(13999)	1.63(17263)	1.65(17440)	1.68(17754)	1.70(18190)	(20500)
Building & Construction	4.13(60440)	3.62(60171)	3.34(49251)	3.24(49870)	3.17(55645)	(59700)
Trade,Restaurants and Hotels	10.26(74882)	10.14(80294)	10.69(84779)	10.94(89710)	11.21(94463)	(10700)
Transport & Communi.	5.85(52780)	6.64(55007)	6.60(54107)	6.45(55670)	6.35(57504)	(60400)
Finance & Insurance	7.08(43654)	7.36(45608)	7.64(50154)	7.69(53363)	7.71(55980)	(60200)
Community, Social and Personal services	(426604)	(451559)	(471009)	(503361)	(519934)	(580600)

Source: Statistical Abstract 1987 and Development Plan 1989-1993

*. indicates projected values

** the share of forestry in the overall indicated figure is less than one per cent

na indicates Data not available

figures in perenthesis represents absolute wage employment by industry

Data of the above table (1.1.1.1) shows that the agriculture sector contributes close to one-third of the country's GDP. Although this share seems to be gradually diminishing, no other sector contributes as much as agriculture does.

As far as employment is concerned, the agriculture sector has remained the second largest employer after community, social and personal services sector. The foregoing contributions of the sector to the overall economic development therefore justifies the fact that agriculture is still predominant in the Kenyan economy. There is hence need to put more emphasis on the sector so as to increase both employment generation and the sector's contribution to national development as a whole.

1.1.2 The Small Farm Sub-Sector

Agriculture production in Kenya comprises of two distinct sub-sectors namely the large farms and small farm[2]. The growing significance of small holder agriculure as shown in the table below calls for a continuing stimulus to be accorded to the sub-sector so as to facilitate its expansion

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2. "Small farms" - include all areas of arable farming which are between o.2 and 12 hectares: see statistical Abstracts Central Bureau of Statistics . (CBS).

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TABLE 1.1.2.1

Gross marketed Production of small farms:

	K£ million	annual percentage change	percentage share of small farms in total
1980	184.5	11.7	52.2
1981	208.3	12.9	53.8
1982	232.2	11.5	51.7
1983	296.0	22.3	51.2
1984	402.53	41.7	51.0
1985	409.31	1.7	54.2
*1986	422.79	3.3	45.1

Sources statistical Abstract 1987

*Provisional

The above table shows that small farm sub-sector contributes over 50% of the marketed outputs; despite the fall in its annual percentage increament between 1984-1985. According to the latest integrated Rural Surveys (IRS) carried out in 1976 to 1979, the number of smallholdings was about 1.7 million and Trans-Nzoia district which is the area of our study had 229, covering 2909 hectares[3].

3. Due to lack of data on small farms, the size holding of 0-19 hectares was taken to represent small farms from the Agricultural Census of large farms 1984-CBS.

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The government has realised the importance of small farm sub-sector and this is why in the present development plan (1988-93) it will pay more attention to the needs of the small holder as far as agricultural input development and use are concerned. The Government stand as far as this issue is concerned can be summarised as follows:

> "While Kenya's large scale farming has benefitted from the use of heavy tractors and other large implements, small-scale farming which accounts for the bulk of agricultural production has lagged behind in farm mechanisation. .... The distribution of these tools will be left in hand of indigenous entreprenuers with government encouragement and support".
> (Development Plan 1989/93: 123).

As it will be shown in the next section, the foregoing government move is on the pipeline. The introduction of tractor hire services coupled with other incentives (see 1.1.3) helps in explaining the trend.

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1.1.3 Tractor Utilisation

Tractors were introduced in Kenya during the second World War (World Bank, 1986:112). Since then, their demand for land preparation has been increasing (see the tables below). The experience of tractor mechanisation in small farm sub-sector has revolved around the strategies of rural development. This mechanisation has been based on hiring of tractors from Government and tractor hire services.

In the 1960s, the settlement of small holders on the formerly European large scale farms increased farm mechanisation and to a large extent, the use of tractors has become a permanent feature of the settlement farming.

In efforts to promote agricultural production, the Kenya Government undertook a strategy to encourage the purchase of tractors by small holder contractors through the provision of finance. It did this with loan funds from the International Development Association (IDA) under the tractor purchases scheme. The scheme operated between 1967-68 during which 210 tractors were purchased, then the government established the Agricultural Finance corporation (AFC) to support a loan scheme to enable more farmers buy tractors for their own use and for contract work on other farms. This has resulted in numerous contractors who operate at least partly in small farm areas in many different parts of the country. Many of these contractors are mobile operating over an area of several hundred kilometres, moving as the season changes, and therefore keeping their tractors busy for

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most of the year (Heyer 1974:7), others are less mobile and they confine themselves to farms around their homes.

The ministry of Agriculture runs tractor hire services which was established in 1966 as a government attempt to set up its own agency on a national scale to engage in farm contracting. With the support of the World Bank, the Government went ahead with the project because it was considered that there were certain areas in Kenya for example Narok, Central Province and Nyanza which offered a considerable scope of mechanisation but due to lack of capital resources and technical know-how agricultural development could not take place. By 1971 the tractor hire scheme had 50 tractors most of them being used for soil preparation (IBRD 1975:481) last still the performance of the scheme is mediocre for the following reasons:

(i) It only ploughs a small fraction of the area done by private contractors

(ii) Its costs are high, for example by 1979 it required subsidies totalling to over K£1 million per year in order to operate.

(iii) 44.5% of tractor time is spent in workshop (Mutabwa 1979).

But despite these notable failures, the government has continued to expand the scheme. In 1988, a total of 30 tractors were given to Siaya and Busia districts and more so, more money is spent on

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the scheme year after year. The government expenditure on tractor hire scheme between 1979 and 1986 as shown in table 1.1.3.1 below indicates that the government attaches great importance to agricultural development and that tractor services are very important to the farmers in Kenya and that is why the government has continued to expand the tractor service scheme.

Table 1.1.3.1

Government Expenditure on Tractor Services

1979 - 1986

YEAR	K £ MILLION
1979	1.981
1980	2.363
1981	2.435
1982	2.523
1983	2.611
1984	2.676
1985	2.944
*1986	1.052

Source: Statistical abstracts 1987, Central Bureau of Statistics, Kenya.

* 1986 - Provisional

On large farms, the demand for tractor services has also been increasing year after year and this has resulted in increase in the number of tractors, despite a small decrease in 1985 as shown by table below:

Table 1.1.3.2

Mechanical Equipment in Kenyan Large farms

1978 - 1986

YEAR	TRACTORS	CRAWLERS
1978	6008	436
1979	6008	360
1980	6180	360
1981	6075	324
1982	6322	332
1983	8200	368
1984	8077	317
1985	6330	338
1986	7536	341

Source statistical Abstracts 1982/87

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The tractor hire service which is run by the Ministry of Agriculure in 1989 introduced the combined hervester hire scheme in order to alleviate the problems faced by wheat growers.

In addition to all the foregoing efforts being made by the Kenya government in the provision of tractor services, the National Bank of Kenya (NBK) has also announced the introduction of "a tractor loan scheme" backed by its current aggresive expansion programme to reach Kenya's rural population[4]. This tractor loan scheme is an attractive package aimed at farmers wishing to buy tractors and other agricultural machinery.

Kenya has a well established tractor industry with so many years of success. The multinational firms supply a wide range of farm implements, sales service, spare parts back up and educational service to farmers. Among the leading suppliers of major farm implements are farm machinery services who distribute the popular range of Massey Furguson, the Gailey and Roberts who market and service the Kubota diesel tractors, the Holman Brothers (E.A.) who distribute John Deere farm implements, the Lima Ltd who distribute international models and the Hughes Ltd who markets the ford tractors (Finance, fabruary 1988:52).

1.2 The Statement of Research Problem

In the previous section, we have seen that in its efforts to promote agrcultural productivity, the government undertook to

4. See: Kenya Times, Thursday March 2nd 1989 Page 22.

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encourage the purchase of tractors by smallholder contractors through the provision of finance and tractor Hire Services. But despite all these efforts, the extents to which tractors are used in small scale agriculture has not been determined. This is something which can be explained in a systematic way through a model of demand for tractor services which this study aims to achieve.

Tractorization may be one way of accelerating development of Kenya agriculture. A study done by FAO 1986 showed that the main source of energy for agricultural production in Kenya is human labour, utilising a limited range of hand tools for example hoe and ox-plough. Given such a situation and also the fact that many agricultural operations can only be done when weather and soil conditions are suitable; the success of such operations may be limited by the shortage of human labour, so that labour demand during peak operations for soil cultivation, weeding and even planting may not be satisfied on time (FAO, 1986:1). We have the view that the amount of work which can be performed by a tractor and its speed could possibly help in alleviating the above cited problem:

The Kenya Government pays more attention to small holders and its concern is to increase the agricultural production of small holders through tractorization (see 1.1.2). Given this Government stand, it is therefore useful to identify the determinants of demand for tractor services in order to assist it in its endavour. At present as we

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shall show in the next chapter, there exists very little information on this subject, and this is due to the fact that the determinants of demand for tractor services have not been fully investigated, although there is a well developed network of tractor service providers in Trans-Nzoia district. In such a situation, even private contractors and the management of tractor hire scheme cannot plan effictively for the provision of tractor service since they may not be in a position to determine what would happen to the utilisation of tractors if the hire charges were to change. There is therefore a need to develop a systematic model for tractor services. This study would generate information that would be useful in planning for effective provision of tractor services to farmers.

1.3 Purpose of the study

The general objective of this study is derived from the foregoing sections, "the generation of information which should permit fuller understanding of tractor services and factors influencing the use of tractors in Trans-Nzoia District".

Farm operations in any agricultural production system is carried out in a certain sequence. This order can also be used for systematization of the types of tractor services that farmers could possibly utilise. Some of these tractor activities which can be employed include:

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(a) Preparatory activities

- Land preparation
- Preparation of plant material

(b) Planting/seeding

(c) Crop management

- fertilizer application
- Irrigation
- thinning and weeding
- crop protection

(d) Harvesting

(e) Transportation

(f) Processing

(Van Heemst at al 1981 in Ruthanberg P.61)

The specific objectivities of the study are:-

(1) To formulate and estimate a model of demand for tractor services in a particular area in Kenya, Trans-Nzoia District.

(2) To determine the main providers of tractor services in Trans-Nzoia.

(3) To determine the most important tractor services and the sequence in which they are utilised by farmers

(4) On the basis of the empiricol findings in (1) through (3), to make practical recommendations that could aid the Government improve tractor hire schemes in Kenya.

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1.4 Significance of the study:

This study is important because it uses empirical data to understand the structure of demand for tractor services. The study aims to generate knowledge on the extent to which certain social and economic factors influence the hiring of tractors. The information which this study will generate, will be of great use to the ministry of agriculture since the site of this study is a key area in Kenya because of its agricultural potentiality.

As it will be evident in chapter two most past studies focused mainly on large scale farms and their results cannot be generalised to explain the demand of tractor services elsewhere; therefore the findings of this study will be of great assistance to the tractor hire scheme and enhance the planning for future provision of these importance services.

Lastly, it is also hoped that our findings will serve as a basis for further research.

1.5 Operational Definitions:

The terms defined in this sub-section will whenever they are used in this text, assume the meanings given in these definitions for the purpose of consistency.

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Small farms:

Include all those areas of arable farming covering an area between 0.2 and 12 hectares.

Mechanisation

Refers to those mechanical aids which are used in production process (farm implements). In this study, the term refers to use a tractors.

Crawlers

Are tractors with large horse power and are capable of doing very heavy work, on farms they may be used for pulling a five to six furrow plough.

Industry

Refers to a group of firms which produce identical products

Land Breaking

In this study the term refers to the first ploughing of the land which has been "virgin" for a long time

An Area

In this study the term refers to a sub-location or part of the sub-location.

Seeds

In this study the term refers to maize and bean seeds.

Fertilizer:

In this study the term refers to the application of calcium Ammonium Nitrate (CAN) and Di Ammonium Phosphate (DAP).

Regressor

A regressor is an explanatory variable and it specifies the individual effect of each independent variable upon the dependent variable while holding the other variables constant. In this study, the terms regressors, explanatory variables, regression coefficient, coefficient estimates, estimated coefficient and perameter estimates are used interchangeably.

Previous session

The current study was carried out in 1989, and therefore the term "Previous season" refers to the 1988 season.

Conversions

1 hectare	=	2.47 acres
1 bag	=	90 kilograms

1.6 Organisation of the remainder of the study

The study is organised in six chapters, which deal with the core topic from six different angles. In the foregoing chapter,

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the introduction was presented and in it, an attempt was made to set up the problem under investigation and also this broad objectives were presented.

Chapter 11 will be devoted to a review of the relevant literature. An examination of the theoretical considerations on the use of tractor and empirical studies which have been carried out on the topic is made.

Subsequently, the author will show how this study links and at same time deviates from these past studies on the demand for tractor services.

Chapter 111 attempts to derive a conceptual framework to be used in the analysis of the chapters to follow. Chapter 1V is devoted to the research design whereas the empirical results of the study is presented in chapter V.

The conclusion to the present study will be made in chapter V1 where the researcher on the basis of the strength of the results of this study will advance his suggestions and recommendations regarding policies which can be made and secondly topic which he feels that are appropriate for further research.

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CHAPTER TWO

LITERATURE REVIEW

This chapter outlines the theoretical considerations and empirical studies which have been carried out on the demand for tractor services. Two types of literature are reviewed, the general literature on the demand for tractor services and the literature specific to Kenya. Also examined is the weaknesses and the strength of these past studies, and hence the position of this study in relation to those earlier studies.

2.1 General Literature

There has been little empirical work done on this topic in Kenya. Most studies which have been done have focused on the general relationship between mechanisation and the level of employment. Such studies include those of Nowack (1968) Brown and Jones (1970) Stabler 1975, Abdel (1980) and the World Bank report of 1982.

We now analyse the main content of these studies taking one at a time.

Nowack (1968) attempted to assess the main factors in the economic evaluation of the efforts of mechanisation in Poland agriculture. His results showed that profit was not always the main factor affecting demand for mechanization systems, but in some cases, demand largely depended on labour shortages.

There is very little similarity between Kenyan agriculture and Poland agriculture though in Kenya we also have government farms for example the ADC farms which are mainly used for demonstration purposes but also aim at making profits, never the less, we do agree with Nowacki's findings that labour shortages is a factor which can determine the use of any mechanisation system and in our study we shall investgate this further by considering the relationship between the farmer's family size and his demand for tractor services.

Brown and Jones (1970) illustrated the course of development of mechanical cultivation in Uganda; they recognised that the introduction of mechanisation besides being a problem in itself, was also conditioned by the assorted type of land tenure. Mechanical cultivation therefore had to be gradually introduced in areas which appeared to offer possibilities of development and emphasis had to be laid on giving the public the opportunity to test the incentives offered by mechanical equipments.

They noted that tractors and other farm implements were expensive to purchase and maintain and hence only fewer farmers could afford them at that time.

The table below shows the trend of usage of tractors between 1950/1967 in Uganda.

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TABLE 2.1.1

Number of Tractors Used in Uganda Agriculture 1950/67

YEAR	GOVERNMENT HIRE SERVICE	NON - GOVERNMENT	TOTAL	*INCREASES
1950	17	40	57	57
1955	11	150	161	104
1960	34	430	464	303
1965	394	665	1059	595
1966	680	655	1335	276
1967	930	730	1660	325

Source: Jameson (1968): Agriculture in Uganda, Page 286

*The increase was calculated from column four.

The increase in number of tractors as shown by column five indicate that their demand was rapid; though there was a slightly small increament in the number of tractors in the year 1966 as compared to 1965, the trend resumed in 1967.

Brown and Jones summarised their findings that the government tractors were mainly required for ploughing which was predominant, harrowing, planting and spraying. They approximated that 60% of the Government tractor hours were spent on ploughing.

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Our current study aspires to find out if this is also applicable to Kenya (see objective number three) and specifically to Trans-Nzoia.

Steblar (1975) had similar conclusions like those of Brown and Jones (1970). He summarised his findings that the demand for a tractor is related to its price and the price of the product. Hence the economic approach to the use of resources in agriculture does not differ radically from that for any other productive activity; since it is a derived demand.

This tudy agrees with Stabler's findings and we are going to try and prove this as indicated in the theoretical framework.

Other considerable empirical evidence is available on tractorization in South Asia, mainly from India, Pakistan, and Nepal. This is an area which has experienced high rates of tractorization.

Binswanger (1977) formulated substitution and the net contribution views for evaluating economic attractiveness of increase in tractor numbers particularly in countries with a relative shortage of land and a surplus of rural labour. Under substitution view, Binswanger looks at tractors and traction animals as two different power sources which are technically substitutes. That operations which a tractor can perform are also feasible with a combination of animal power, animal-drawn implements and hand labour. He therefore suggests that for a developing country with abundant labour supply and little land, time to switch to tractors has not yet come. That tractorization in the foregoing case would lead to a loss in national income and a redistribution of income in favour

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of large scale farmers who are in a position to employ tractors more effectively than smallholders.

The net contribution view considers tractorization as an essential in agricultural development. He therefore sights at the benefits that a farmer gives from a using a tractor for farm operations.

Binswanger evaluated these substitution and contribution views in 1978 under India's experience. His evaluation can be summarised as follows:-

> "The tractor surveys fail to produce evidence that tractors are responsible for substantial increases in intensity yields, timeliness and gross returns on farms in India, Pakistan and Nepal. At best, such benefits may exist but are so small that they cannot be detected and statistically supported, even with massive survey research efforts..... ..... Indeed, the fairly consistent picture remerging from surveys largely supports the view that tractors are substitutes for labour and bullock power".
>
> (Hans Ruthanberg 1985: 68)

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From Binswanger's evidence it appears that both the private and the social profitability of tractorization is low. This hence leads to the question, "why do farmers tend to invest heavily in tractors?" Possibly, a reduction in wage costs, labour trouble and the complexity of the enterprise explain the tendency towards tractorization on large farms. But how can we explain this phenomenon of tractorization on small farms?
This question forms the basis of the current investigation.

Ruthenberg (P.69) makes a theoretical comparison of tractorisation in Thailand and Brazil based on the relative efforts of distribution, efficiency and expansion of tractors and concludes that tranctorization in these two countries is influenced by the following policies. Subsidization of the purchase price of tractors in Bazil favours large farmers. In Brazil, the subsidization of interest rates constitute a specific policy to promote tractorization. Whereas in Thailand, the organization of a tractor hire service reduces the problem of the lumpiness of this type of investiment/innovasion and makes it attractive for the small farmer.

Klempin(1979) examined the experience with tractorization in Saraburi scheme, Thailand. Saraburi settlement scheme was an area where settlers had 4 hectares of land and had relied on buffalo traction for a long duration but latter changed to partial tractorization whereby they used hired tractors as opposed to purchased ones on certain farm operations mainly for land preparation in the cultivation of maize and beans. Planting, weeding and harvesting activities were done by animals and hand labour.

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Klempin interviewed 95 farmers on their perception of the impact of tractorization. Those farmers whom he interviewed, explained the economic success of tractors as follows:

(1) Tractors operations allow better timing. A buffalo working day has 6 hours, while tractors operate in peak seasons day and night.

(2) Tractors ploughing provides better weed contrast.

(3) The rectangular lay-out of fiolos allows efficiency tractor operations under small farm conditions.

(4) Tractors serve for several but clearly defined purposes in the farming custom:: Ploughing, shelling and transport.

(5) The great amount of effective and fairly homogeneous demand of tractor services favours the establishment of highly competitive contract services.

As part of our investigation, we are going to look further into Klempin last two findings to determine if they also conform to Kenya's situation.

Other studies which have been carried out on tractor utilisation are those of Abdel 1980.

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Abdel (1980) enumerated some of the tractor services in Egypt. He estimated that from the country's tractor population of 29,350;8,410 were used on state farms and co-operatives. The rest 20,940 were owned by individual farmers. The Egyptian farmer acquires a tractor mainly for ploughing and preparing the seedbed, but since these activities are seasonal, the rest of tractors time is used for transport. He estimated that only 30% of the tractor's working hours are used in ploughing while 70% are spent in pulling trailers and other stationery operations such as running water wheels for irrigation purposes, pulling simple threshing machines for wheat barley etc.

Abdel's findings contradicts Jones and Brown (1970) who found out that 60% of tractor hours are spent on ploughing (see above).

In his study, Abdel pointed out that labour shortages, rising wages, immigration of youth to cities and industrial centres, all have had a great impact on the demand for tractors by farmers. To some extent, this results concides with those of Nowacki 1968 who illustrated that the use of tractors largely depended on labour shortages.

We do agree with Abdels' results to some extent and in our study, we are going to find out ot what extent, changes in wage rates has affected the demands for tractor services in one of Kenya's district Trans-Nzoia.

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Livingstone and Ord (1981: 207) indicated that a tractor can only be used if land topography of a given area is suitable for tractorizasion. That if the ground is stony, a tractor may not be efficient or their use may involve costly breakages in ploughing. They insisted that given the suitable physical conditions still, whether the purchase or hire of tractors is worthwhile will depend on its costs compared to the benefits derives from it which may be either in terms of increased output or in terms of reduced costs of other factors of production.

We would like to add that the efficiency that comes as a result of the use of tractors and the time saved may be some other important factors which a farmer may consider in relation to costs.

World Bank (1982) demonstrated that the speed at which farming becomes mechanised depends on the relative scarcities of land and labour, unless government subsidize mechanisation. The report showed that in Asian agriculture, due to abundant labour, machines are used first for operations where concentrated power or speed are superior to human labour or animal drawn implements for example stationery threshers mills and water pumps. The report indicated that tractors are used for clearing heavy land and also for transport. In recent years power fillers have been used for mechanized puddling of rise fields in Thailand and Phillipines. The shift to mechanized power in response to labour shortages and rising real wages is very selective.

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Hence many farmers use tractors in order to mimimise costs.

This World bank Report agrees with earlier studies that the use of tractor services is a result of labour shortages rising wages, which the current study will also consider.

.2. Literature Specific To Kenya

Very little studies have been done on this topic in Kenya. Most of the past studies have dwelt much on large scale farms and therefore little attention has been devoted to small scale farms. Such works include those of Clayton (1960 and 1963), Maitha (1973), Hayer (1974), Obara (1980), Kosura (1983) and FAO (1986)

In what follows; the main ideas of the above authors are discussed.

Clayton (1980) suggested that the demand for tractor services depended on the rate of employment and total arable on large farms. The growth of the number of tractors on large farm sector before Kenya's independence had a negative effects on employment. The increase in use of tractors on large scale farms lead to a reduction in the demand for labour as indicated by the table below:

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TABLE 2.2.1

Mechanisation and Employment
In Kenya large farm Sector 1956/59

	1956	1957	1958	1959
Total area ('000ha)	2933.7	3024.7	3066.0	3114.0
Arable land ('000 ha)	397.8	425.7	399.1	404.4
Number of Tractors	5704	5863	6123	6332
Arable ha per tractor	68.6	72.6	65.1	64.9
Total labour employed ('000)	285.3	258.1	250.4	257.1

Source: clayton (1972) Machanisation and Employment in East Africa Page 15

The weakness of clayton study is that he did not show to what extent the rate of employment and total land acreage affected the demand for tractots. This weakness forms part of our investigation especially the acreage factor.

Also we need to note that what was a large farm in Kenya in 1960 might not be a large farm today.

Clayton again in 1963 carried out an evaluation of use of tractors in Nyeri District. In this study, he examined the relationship between the use of tractor and employment of paid labour. He noted that enlarged labour supply allows an expansion of the acreage under cash-crop to take place the thus reduces the demand for tractors. His conlusions were that the farmer preferred to hire tractor if labour

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which is released by mechanisation can be put to productive use or take over tasks previously done by the family.

In this study, we can make a deduction that a tractor and human labour are substitutable on small farms.

Maitha 1973) had the objective of constructing an econometric model to explain the demand for tractors in Kenyan agriculture. His major aim was examine the causes of mechanisation and its effects on the level of employment in large scale farms. The study examined the factors affecting the demand for agricultural machinery.

Maitha noted that the major causes of unemployment in large farms was the substitution of other inputs for labour, and that the most obvious substitution for labour is mechanical machinery and that mechanization of large farms in Kenya seems to be dominated by large tractors and combined harvesters; and that the tractor -hectare ratio was increasing over time. But the acreage in the large farm sector was falling. Maitha specified his demand model for tractors as follows:-

$$T^* = f(P_T, P_o, P_P, X, r) \quad \ldots\ldots\ldots (i)$$

where

T^* = Desired stock of tractors

P_T = prize of tractors

P_O = prize of other inputs

P_P = price of products

X = Other unspecified variables

r = Rate of interest.

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The results of Maitha's study can be summarised as follows:

$$\text{Log } T_t = 9.92 - 0.637\ P_t + 0.5 \log W + 0.273 \log R_{t-1}$$

(see) (0.158) (0.293) (0.254)

$R^2 = 0.817$

SEE = 0.054

The results indicated that the prize of tractors, the wage rate and the lagged revenue had an impact on the demand for tractors although they were not the only factors.

The regression model indicates that 82% in the variation of stock of tractors can be explained by the above mentioned factors alone. Thus if the level of wages and lagged revenue are held constant and the price of tractor falls by 10%, the stock of tractors would increase by 6%.

Similarly, holding the price of tractors and Revenue constant, a 10% rise in the level of wages would lead to a 5% rise in the stock of tractors. These results led Maitha to conclude that the rising levels of wages have played a significant role in agricultural mechanisation.

Our study deviates from Maitha's in the following ways:

(i) We are going to include the levels of output and acreage in our model.

(ii) Only small farms have been considered in this research

(iii) We have used primary data as opposed to secondary data.

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Another interesting study was that of Hayer (1974). Hayer carried out a survey on use of tractors and oxen in Makueni (Machakos District) and Bungoma. The survey was intended to:

(i) provide information on the extent to which tractors and oxen are used in areas reputed to have strong traditions of ox-cultivation and also quite wide-spread

(ii) Explain differences between farms with respect to the use of tractors and oxen....."

(Hayer 1974, P 68)

Hayer noted that the demand for tractors was high in areas of low rainfall where timing of cultivation, planting and weeding operations are crucial.

In Makueni, her rsults showed that farmers were more senstive to the price of tractor here service and that 33% of the farmers would no longer use tractors if the price was increased; 27% maintained that they would no longer use tractors if the price went up by 50%; and a further 26% if the price went up by 100% and 14% would still use tractors if price went up by 200%.

In Bungoma, 53% maintained that they would use tractors still even if the price of hiring the tractor service went up by 200%. Infact they preferred to reduce the area under cultivation in order to save costs. We are also going to consider the relationship between price and use of tractors.

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Obara (1980) analysed the determinants of small holder cotton farm mechanization. His study showed that the decision to employ a tractor was considered on several grounds; economic, social, political and technical. In addition environmental factors play a major role in determining their use.

Obara considered the payment for the tractor service by the farmer as a difficult because the income of small cotton farmers is not sufficiently high and stable. He argued that the farmers' land is in a minimum position hence profits due to the tractor use should be high to justify the use of tractors. Agricultural education was seen as a pre-requisite to the use of tractors that since it gives adequate attention to farm management; farm fragmentation which is a common feature of small farms is another factor where by long distance between parcels of land take time and energy. Hence distance between individual parcel can be covered much quicker when a tractor is employed. The major weakness in Obara's study is that it lacks an empirical foundation.

Kosura (1983) examined the economics of mechanisation in small farms in Western Kenya. He was interested in identifying the relationship that exist between mechanisation and other factors confronting the farmer and hence he has to make his farm ready for planting on time. In a section of his conclusions,

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he (Kosura) mentions the cost of hiring oxen for ploughing as a factor which also affects the demand for tractors in that when the cost of ploughing using oxen changed, the use of tractors followed suit; we shall also consider this.

FAO (1986) concluded that the demand for small farm mechanisation is derived from the need to provide for oneself and one's family. The use of tractors depends on their availability in a given locality reliability and convenience.

FAO's analysis can be summarised as:-

> "Few small-holders can actually choose between a tractor and oxen. Both certainly have a place in Kenya agricultural production. Tractors are more expensive, less available, less reliable, less versatile, but more convenient than oxen. Thus individuals prefer tractors because of their convenience but this may not be in national interest." (FAO, 1986: P2).

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This quotation summarizes 'FAO's' position that the use of tractors by small farm holders is considered on social - economic grounds.

Our study aspires to consider some of the factors put forward by FAO for example the availability and reliability of tractors as it affects their demand. We shall consider this factor in form of distance and hence analyse the relationships between the demand of tractor services and the distance in kilometers from where the tractor was obtained.

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Lastly, we are going to combine most of the factors which past studies have used and also introduce others which have not yet been considered (see 3.1) and show how these factors affect demand for tractor services in Trans-Nzoia district. It is evident from both the empirical work and theoretical considerations analysed above that most past studies have tended to focus on the general relationship between mechanisation and level of employment on large scale farms hence neglecting the role played by small farms.

CHAPTER THREE

DETERMINANTS OF DEMAND FOR TRACTOR SERVICES

THE THEORETICAL-ANALYTICAL FRAMEWORK

This chapter is divided into three sections. The first section explains the derivation of the conceptual structure which will be used in the next two chapters. The second section spells out the hypotheses to be tested and lastily the third section shows the multiplicative model which was estimated in Chapter V using the ordinary least squares (OLS) technique.

3.1 Theoretical Formulations

In this section, a simple and specific model of demand for tractor services is formulated. The model is constructed with the assumption that each tractor service choice involves costs and other factors, secondly that the demand for tractor services is a derived demand. A farmer will use a tractor only in so far as its use contributes to the production of goods valued by consumers incase he is going to sell his farm produce.

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A simple demand equation derived from the maximisation of an individual utility function subject to a simple budget constraint in terms of a two-good world of those produced by using tractor services (G_T) and all other goods and services (X) purchased by a farmer can be presented as follows:-[1]

1 Maximise $U_i = U_i(G_T, X)$ .....(i)

2 Subject to $P_T T + P_x X = Y$ .....(ii)

$G_T = G_T(T)$ ..... (iii)

where

U_i = Utility of farmer i

G_T = goods produced using tractor services

X = A composite of all other goods and services

P_T = price of a unit of tractor services

T = a constant quantity unit (or vector) of tractor services used by a farmer

P_x = price of a unit of other goods or services

Y = individual income of a farmer using a tractor, which is completely exhausted by expenditures on T and X

$G_T(T)$ = shows that goods produced using tractor services is a function of the units of tractor quantities used.

1 See intrilligator, M. Econometrics models, Techniqes & applications: P207

Income and price are measured to be given positive constants. From the budget constraint (ii), the farmer thus chooses among bundles that satisfy the budget constraint so as to attain the highest available level of utility. There will be hence the optimal quantities demanded of T and X.

The demand functions give the dependence of the (optimal) quantities demanded on all parameters of equation (ii), namely the prices and income.

$$T = T\ (P_T\ ,\ P_x\ ,\ Y\ ) \quad \ldots\ldots\ldots (iv)$$

equation (iv) indicates that the amount of tractor services (T) demanded is a function of price of tractor service (P_T), price of other goods (P_x) and the farmers income level (Y).

Holding P_x and Y constant in equation (iv) gives as the demand curve for the tractor services (T):

$$T = D\ (P_T) \quad = \quad T\ (P_T\ ,\ \bar{P}_x\ ,\ \bar{Y}\ ) \quad \ldots\ldots$$

where ... (v)

- $D(P_T)$ is a demand function of tractor services given as a function of price of tractor services alone; cateris paribus
- The bars ($\bar{P}_x$ and $\bar{Y}$) indicates that these parameters have been held constant.

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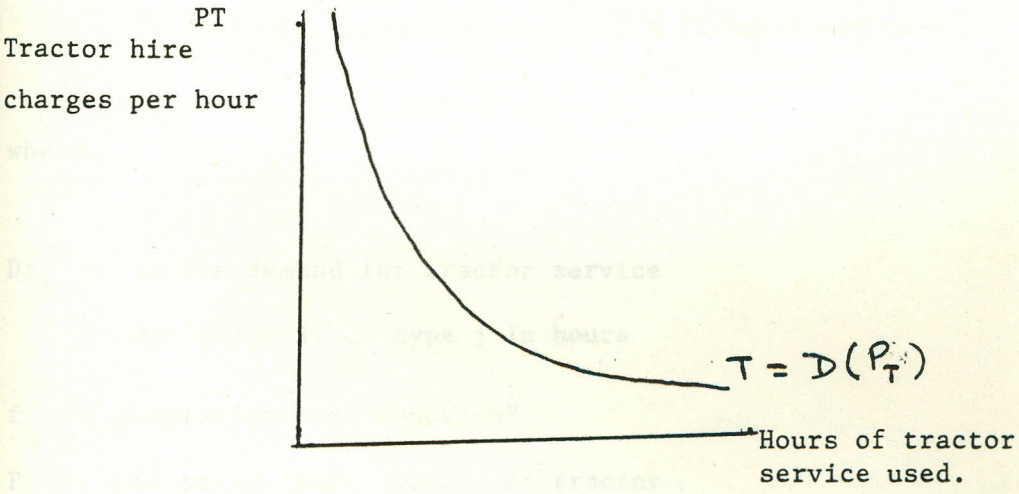
The above representation of quantity of tractor services (T) in equation (V) hence mean that the quantity of tractor services demanded is a function of price (hire charge) of tractors alone; (which is the usual definition of demand for acommodity)

Figure 1

A diagramatic representation of demand for Tractor Services



The above demand curve indicate the effect of a change in the price (hire charge) of tractor on the quantity of tractor services demanded by a farmer; holding other factors constant i.e., the ceteries paribus effect of a change in "own" price.

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A change in other factors (P_x , Y) will lead to a shift in the demand curve. Therefore incorporating other social and economic shift parameters in equation (v) and holding them constant leaves the demand curve unchanged. We can therefore generalise the demand function (v) for a farmer who hires a tractor for farm operations as follows:-

Di_j = f(P, V, Y, L, Q, B, E, G,
Z, A, W, u).....(vi)

i = 1, 2, ...n (farmer)

j = 1, 2, ... m (tractor services)

where

Di_j = is the demand for tractor service by farmer i of type j in hours

f = a notation for "function"

P = the price (hire charge) of tractor service in Kenya shillings per hour.

V = the price of products produced using tractor services

L = land acreage for individual farmer in acres.

Y = monthly income of the farmer

Q = farm output in bags

B = price of other farm inputs.

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E = education level of a farmer in years

G = agricultural training

Z = Distance from where a tractor was obtained in kilometers.

A = age of farmer

W = hourly wage rate

u = a stochastic term.

The socio-economic factors in equation (vi) were therefore postulated to be determinants of demand for tractor service and data described in chapter lv is based on these factors.

3.2 Hypotheses

In this section, the broad hypotheses which the study seeks to test are presented: They include:-

1. There exists a negative relationship between the demand for tractor services and the price (hire charge) of tractors.

2. There exists a positive relationship between farm output and the demand for tractor services.

3. There exists a positive relationship between the demand for tractor services and farmers' land acreage.

4. The relationship between the demand for tractor services and the price of other inputs could be universe of positive

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depending on whether these alternative inputs are complements or substitutes to tractor services.

3.3. The estimating Equation

In order to estimate the effects of various parameters given by the demand function (vi) in section 3.1 on the quantity of tractor hours utilised by farmers, the researcher specified the functional form of the demand function for tractor services in the log-linear (constant elasticity form) as follows:-

$$T_j = A, P^{B1} V^{B2} L^{B3} Y^{B4} Q^{B5} \ldots\ldots\ldots e^{ui} \ldots\ldots\ldots\ldots (2)$$

where

T_j = Tractor hours typer j used

A_1 = a constant

e = the base of natural logarithm

(e ≡ 2.71828)

B1, B2.....Bk are the coefficients to be estimated.

explanatory variables remain as they were in section 3.1

ui = stochastic term which is added to the model in order to account for:

(1) other ommited explanatory variables

(2) Mispecification of the equation

(3) any possible errors which might occur during measuring the variables:

Taking the natural logarithms of equation (i) above leads to the double log-linear representation of the demand function:

$$\ln T_j = Ao + B1\ln P + B2\ln V + B3\ln L$$

$$+ B4\ln Y + \ldots\ldots\ldots\ldots + u_i \ldots\ldots\ldots (ii)$$

where

$\ln = \log_e$ (natural logarithm)

$Ao = \ln A_1$ (which is a constant)

$B1, B2 \ldots Bk$ = coefficient estimates

Equation (ii) now becomes the model which the study will use in the estimation of various coeficients.

The log-linear mathematical form was chosen because it is easier to interprate the coefficients when used and secondly, the coefficient estimates are elesticities:

In the actual estimation whose regression results are presented in chapter v, a number of dummy variables were introduced to act as proxies to qualitative variables such as sex, different education levels. etc. Also, since in regression analysis, the effects of the independent variables are additive, a number of explanatory variables were interacted in order to find out their "joint effect" over and above other explanatory variables.

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CHAPTER FOUR

DATA AND SURVEY METHODOLOGY

In this chapter, the various types of data used in the study and the sampling procedure are discussed.

4.1 Study Area.

This study was carried out in Trans-Nzoia district (see map 1). This site was selected for two main reasons.

(1) No such study had been carried out in the area, yet the district is one of the few districts in the country with a very high production potentialities, and it was thought that such a study could help increase its agricultural production.

(2) The choice of the area was purposeful because it has numerous small farms.

Trans-Nzoia (Map 1) covers an area of 2468km^2 (Development Plan 1984/88:1) it is one of the districts which make up the Rift Valley Province. The district covers an area of 0.42% of the Republic of Kenya and 1.4% of the Rift Valley Province. (It borders Kakamega and Bungoma Districts of the Western Province to the South, Uasin Gishu and Elgeyo - Marakwet to the East, West Pokot to the North and Uganda to the West).

The district is divided into three administrative divisions which are Cherangani, Kwanza and Saboti. It has a highland equatorial type of climate. The district's population was 259,503 persons as per the 1979 census (which is the official latest census). Agriculture is the backbone of the district's economy hence the income earning. Opportunities and employment opportunities linage on the agricultural industry and land holding system. For so many years now, Trans-Nzoia has been the leading stable maize producer in Kenya and this trend is likely to remain so as long as the productivity is increased. More than 80% of the district is highly potential agricultural land. The district which formerly had many large farms is steadily changing to smaller holdings due to land sub-division and increase in population.

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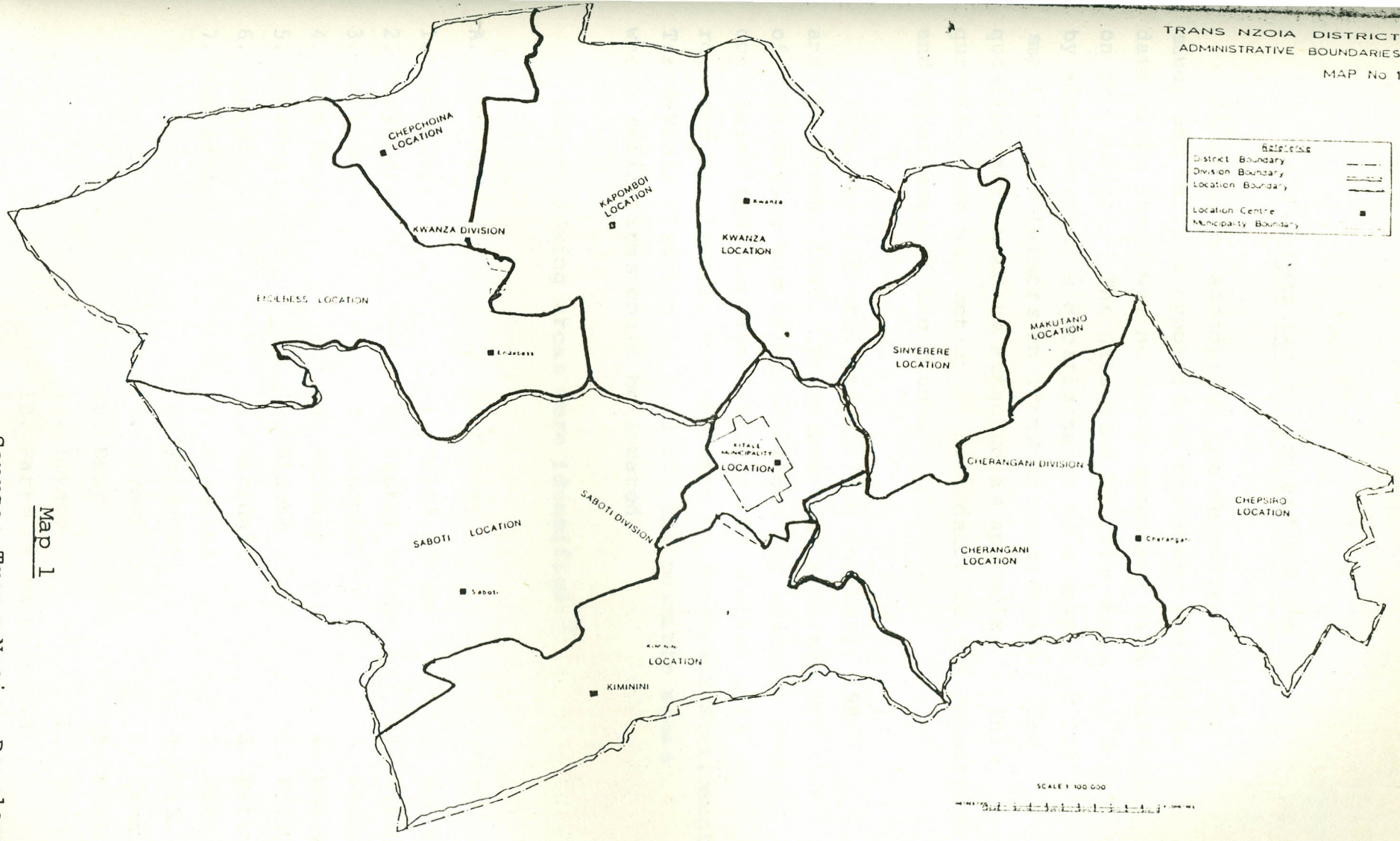

Map 1

Source: Trans-Nzoia, Development Plan; Page 1

TRANS-NZOIA DISTRICT

ADMINISTRATIVE BOUNDARIES

4.2 Data Collection and Analysis

In order to accomplish the objectives of the study and various hypotheses, the study uses primary data since there was no ready secondary data available on the subject. The data used by this study was collected by administering a questionnaire to a sample of 113 small holder farmers in Trans-Nzoia district. The questionnaire used is attached as appendix 1. This questionnaire was set up in accordance to the objectives and hypotheses of the study.

Data was gathered between 4th February, 1989 and 7th March, 1989. To ensure that accurate set of information was gathered within the research budget constraint and time availability, we started this research by visiting the Ministry of Lands and Settlement Trans-Nzoia district to find out the possible areas where small farms could be located.

The following areas were identified:[1]

A. Cherangani	B. Kwanza	C. Saboti
1. Sitatunga	1. Twiga Scheme	1. Bikeke
2. Sinyerere	2. Kapkoi Scheme	2. Sirende
3. Cherangani	3. Kapomboi	3. Wamuini A
4. Mito Mbili	4. Ndalala	4. Wamuini B
5. Siwerwa	5. Gideche	5. Kiungani
6. Kiptoi	6. Maridadi	6. Matunda
7. Kiptarwa	7. Kipsaina	7. Parts of Kimini
	8. Kaisagati	8 Nyasi Scheme
	9. Siyoyi	9. Chemichemi
	10. Emuru	10. Sikiriwa
	11. Liyabo	11. Birunda
	12. Parts of Namanjalala	

1. Personal interview with Mr. Omakada, a lands officer with Ministry of Lands and Settlement, Trans-Nzoia District.

After identifying some of the possible areas where small-scale farmers could be located, we carried out our research based on the above information. We then visited farmers in their homes and interviewed the head of the household whom we found. Homes where only children were found were avoided.

In what follows we briefly discuss the type of data we collected and how this data was treated in the analysis. At the intial stages of the interview we seek to know the identifications of the respondent; which included his division, location and sub-location. Then next we recorded his sex which was treated as a dummy variable in the analysis, the male respondents were assigned a value of one and the females a value of zero; hence in this case female were used as a reference category in order to avoid the problem of dummy trap.

The respondent was then asked to give his level of formal education in years, family size and age. We treated education as a dummy variable: Five categories of education were identified.

1. no formal education at all
2. those who were in school for almost seven years
3. those who were in school for a period of seven to thirteen years
4. those who were in school for more than thirteen years.
5. others

Here again other was used as a reference category. Family size and age were entered into the model as quantifiable variables.

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After the respondent had stated his age, education level and family size; we then asked him to state his main occupation. Agroup of various major occupations were identified and in the analysis we grouped them into:

1. farming
2. others

and treated the information as a dummy. Further we sought to know if the respondent used a tractor in the previous seasons. In case he did not, we asked him to explain why he did not use. In case the anwer to the foregoing question was 'yes', the respondent was asked to explain what he used the tractor for, the duration in hours the tractor was used and the charges per hour, day, month etc.

In order to analyse the information, we came up with five categories of tractor uses: These were: These were:

1. Ploughing, which included land breaking
2. Re-ploughing
3. Transportation
4. Shelling
5. Other activities, which included the following activities; planting, harrowing, weeding and spraying.

During data collection, it was discovered that farmers were being charged per acre[2] and not per hour and therefore, to be able to determine the charges per hour for every activity the following formular was used.

$$P_i = \frac{\text{Charges per acre in Kshs X no of acres}}{\text{Time in hours, the tractor was ued}}$$

Where i = 1,2,5 the above activities.

2. We used acres and not hectares because in Kenya land is still measured in this units.

We had to convert charges per acre into charges per hour due to the nature of the dependent variable.

P_i = Charges for activity i per hour

The above formula is only applicable to the following activities i.e. ploughing, Re-ploughing and others.

For transportation and shelling the following formula was used for transormation:

$$P_i = \frac{\text{Charges per trip (bag) X no of trips (bags)}}{\text{Time in hours, the tractor was used}}$$

$i = 3, 4$

P_i = as above

We then coded the above transormed information as variables.

The respondent was further asked where he obtained the tractor, both the distance and place were recorded. The information on distance was treated just like any other quantitative variables above. Whereas place was used in identifying the tractor providers. In order to meet our objective 2

Next we sought to know if the respondent had farm employees; the number and wage rate were recorded. The information on presence of farm employees was treated as adummy; which was normalised with their absence.

We then sought to know other farm implements that the respondent might have used and the amount of money he spent on them and the activities which these implements were used for.

To guide him, we asked whether he had used oxen in the previous season. The rest of the farm implements mentioned by the respondent were coded under "other implements" for the analysis purposes.

Further we asked the respondent to give his land acreage and the portion of 'this' land which was under farming in the previous season. Then we sought information on the crops he grew and the amount he had produced, sold and lastly the selling price of these output per bag. Each of this information was treated as a variable in the analysis. Another parameter which we were interested in was the total monthly personal earnings of the respondent. The following income categories were provided and we asked the respondent to choose the one he belonged to:-

1. Ksh 0 - 200
2. " 201 - 1000
3. " 1001 - 2000
4. " 2001 - 3000
5. " 3001 - 4000
6. " 4001 - 5000
7 " 5001 - 6000
8 " 6001 - 7000
9 7001 and above .....(specify)

For the analysis purposes, we coded the mid point of every category as a representative monthly income of the group. For example category number 4 Ksh 2001 - Ksh 3000, we coded Ksh 2500.

Last but not least, we asked the respondent whether he had received any agricultural training and incase he had, we explored to know the place and duration in months, we then treated this as adummy and mutiplicative variable respectively. Our last question was on other farm inputs used in the previous season.

In this question our main concern was the input, the quantity of input used and the cost per unit of the input. In the analysis, we come up with two distinctive inputs i.e. seeds and fertilizers which were treated as variables.

4.3 Sampling Procedure:

In the last two sections, the information concerning the study area and the type of data collected were examined. In this section, an attempt is made to show the sampling procedure adopted during the study. We choose at random the areas to be visited from the list given in section 4.2; but although this was done, we ensured that our random sample had at least three different locations in every division.

Initially we had planned to interview 100 farmers who used tractors, i.e. at most 30 or 40 from every division. But in the actually survey, it turned out that we had interviewed 113 though in the final analysis we used only 106 cases because other cases were incomplete. These respondents are distributed as follows:

Cherangani Division had 37 respondents representing 34.9%

Kwanza Division had 36 respondnets representing 34%
Saboti Divisiion had 33 respondents representing 31.1%

The other 7 cases were not used in the final analaysis because of incomplete information and spoilt questionnaires. In the next section, we briefly discuss some of the problems we experienced during data collection and also the reliability of the data.

4.4 Problems Encountered during data collection and the reliability of data

Due to the budget and time constraint, we started our interviewes as early as 7.30 a.m. and continued up to 7 p.m. depending on how far the area was from the main road; this helped the researcher to be able to interview as many farmers as he could. The major difficulties encountered were:-

1. The site of interview was farmers' homes the researcher had therefore to cover very long distrances on foot in the hot sun. In some cases the interviewee would be absent due to the difficult of making prior appointments with him.

2. Some respondents were not willing to be interviewed whereas some were reluctant to give information on their land acreage. This problem was overcame by reframing the question relating to land acreage as follows:

   (a) What portion of your land did you cultivate in the previous season?

   (b) How much did you pay for the tractor owner to do this.

Using the above question, it became easier to determine the size of land one owned.

Though we consider the data we collected to be reliable since it represent the actual view of the respondnent on the problem under investigation, there might be some weaknesses in the data, since most of the questions we asked farmers were concerning the previous seasons.

1. Some respondents could not recall the actual prices and amount they spent on some inputs, hence they had to make approximations.

2. The depedent variable of the model specified in section 3.3 of Chapter 4 is measured in hours that the tractor was used. There is a possibility of farmers giving information which deviates from the actual value since they had not foreseen the possibility of being interviewed on the subject.

Therefore the results of the study should be viewed in this context.

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CHAPTER FIVE

DETERMINANTS OF DEMAND FOR TRACTOR SERVICES

EMPIRICAL FINDINGS

In Chapter four, we discussed the various data used in this study and how it was collected. In this chapter, we present the empirical results of the study.

We start by presenting the variables used in the analysis. The natural logarithm of various variables was taken.

5.1 Table of Variables

VARIABLE	LOG OF VARIABLE	VARIABLE DEFINITIONS & REMARKS
A	A = LN(A)	The age of the respondent. It straightforward uses the reported age in years
F	F = LN(F)	Family size of the respondent. This is a discrete variable
TI	If TI > 0 Then TI= LN(TI)	Time in hours, the tractor was used for ploughing. The variable is continuous.
T2	If T2> 0 Then T2 = LN(T2)	Time in hours, the tractor was used for Re-ploughing.
T3	If T3 > 0 Then T3 = LN(T3)	Time in hours, the tractor was used for Transporting farm produce from the farm to home stead.
T4	If T4 > 0 Then T4 = LN(T4)	Time in hours, the tractor was used for Shelling.
T5	If T5 > 0	Time in hours, the tractor

VARIABLE	LOG OF VARIABLE	VARIABLE DEFINITIONS AND REMARKS
	T5 = LN(T5)	was ued for other activities Under this category of other activities, harrowing, planting and spraying were considered.
P1	If P1 > 0 P1 = LN(P1)	The hire charge of a tractor for ploughing per hour in Kenya Shillings
P2	If P2 > 0 P2 = LN(P2)	The hire charge of a tractor for re-ploughing per hour in Kshs.
P3	If P3 > 0 P3 = LN(P3)	The hire charge of a tractor for transport per hour in Kshs.
P4	If P4 > 0 P4 = LN(P4)	The hire charge of a tractor for shelling per hour in Kshs.
P5	If P5 > 0 P5 = LN(P5)	The hire charge of a tractor for other activities in Kshs.
Z	If Z > 0 Z = LN(Z)	The Distance in Kilometers from the farmer's farm to the place where the farmer obtained the tractor.
W	If W > 0 W = LN(W)	Labour wage rate per hour This is a continuous variable measured in Kshs.
X	If X > 0 X = LN(X)	Charges for Ox-Plough per acre in Kshs.
L	L = LN(L)	Farmer's land acreage as measured to the nearest acre

VARIABLE	LOG OF VARIABLE	VARIABLE DEFINITIONS AND REMARKS
N	N = LN(N)	The portion of the farmer's land devoted to farming in acre
C	If C > 0 C = LN(C)	Charges for other implements per acre.
Q1	Q1 = LN(Q1)	Quanity of maize produced by farmer in bags.
Q2	If Q2 > 0 Q2 = LN(Q2)	Quantity of beans produced by farmer in bags
S1	If S1 > 0 S1 = LN(S1)	Amount of maize sold in bags
S2	If S2 > 0 S2 = LN(S2)	Amount of beans sold in bags
V1	If V1 > 0 V1 = LN(V1)	Is the selling price of maize per bag.
V2	If V2 > 0 V2 = LN(V2)	Selling price of beans per bag.
Y	Y = LN(Y)	The average monthly personal income of the farmer in Kshs.
G	If G > 0 G = LN(G)	Duration of agricultural training of a farmer in months.

VARIABLE	LOG OF VARIABLE	VARIABLE DEFINITIONS AND REMARKS
B1	B1 = LN(B1)	Average price of fertilizer per kilogram
B2	B2 = LN(B2)	Average price of seeds per Kilogram
E	-	Education (formal) attained in years
D1	-	Adummy variable taking a value of one if male otherwise it takes a value of zero. This is a qualitative variable.
D2	-	Adummy variable taking avalue of one if E = 0, otherwise it takes avalue of zero.
D3	-	Adummy variable taking avalue of one if $0 < E < 7$, otherwise it takes avalue of zero.
D4	-	Adummy, D4 = 1 if $7 < E < 13$ otherwise D4 = 0.
D5	-	Adummy, D5= 1 If $E > 13$ Otherwise D5 = 0
D6	-	Adummy, D6 = 1 if respondent's main occupation is farming Otherwise D6 = 0.
D7	-	Adummy, D7 = 1 if respondent has farm employees, otherwise D7=0
D8	-	Adummy, D8 = 1 If respondent used Ox-plough, otherwise D8 =0.

VARIABLE	LOG OF VARIABLE	VARIABLE DEFINITIONS AND REMARKS
D9	-	Adummy; D9 = 1 if respondent received any agricultural training otherwise D9 = 0.
M1	-	D2 intaracted with Y
M2	-	D3 Interacted with Y
M3	-	D4 Intercated with Y
M4	-	D5 Interacted with Y
M5	-	V1 Interacted with P4
M6	-	X Interacted with B1
M7	-	X Interacted with B2
M8	-	D2 Interacted with G
M9	-	D3 Interacted with G
M10	-	D4 Interacted with G
M11	-	D5 Interacted with G
M12	-	D6 Interacted with G
M13	-	Y Interacted with V2
M14	-	Y Interacted with B1

VARIABLE	LOG OF VARIABLE	VARIABLE DEFINITIONS AND REMARK
M15	-	Q2 Interacted with Q1
M16	-	B2 Interacted with B1

Where

> means greater than

< means less than

LN() natural logarithm of the variable in the parenthasis.

In table 5.1, the middle column (log of variables) was introduced because of the nature of the estimating model: It was necessary that before taking the natural logarithm of certain variables, selection should be made to eliminate those with zero values so as to prevent the whole model from collapsing to zero (see 3.3) In this study we only considered major crops grown in Trans-Nzoia which are maize and beans.

5.2 Descriptive Statistics

In this section, we present (in table 5.2.1) selectively descriptive statistics of various variables which we presented earlier (see 5.1).

As data in table 5.2.1 show, the average age (A) of the respondents was 39.7 years. The youngest farmer interviewed was 16 years. Whereas the oldest was 68. The sample survey revealed that most of the farmers are between 34 - 50 years of age.

The results also indicated that the mean years of formal schooling of farmers in Trans-Nzoia is 6 but the majority of the population, about 26% had, no formal education.

TABLE 5.2.1 Atable Showing Various Descriptive Statistics of Variables

VARAIBLE	DEFINITION	MIN VALUE	MAX VALUE	MEAN VALUE	MODE	MODE PERCE-NTAGE	STD DEV
A	Years	16	68	39.7	30	5.7	11.2
E	Years	0	17	6.0	0	25.5	4.6
F	-	1	24	9.1	8	14.2	4.2
T1	Hours	0	9	4.3	3	17.9	2.9
T2	Hours	0	9	2.4	0	43.4	2.8
T3	Hours	0	24	2.9	0	54.7	5.5
T4	Hours	0	9	2.6	0	46.2	3.0
T5	Hours	0	9	2.0	0	55.7	2.9
P1	Kshs	0	520	229	250	7.5	112.4
P2	"	0	460	158	0	43.4	155.5
P3	"	0	320	44.	0	54.7	70.8
P4	"	0	675	73	0	46.2	104.0
P5	"	0	560	84	0	55.7	126.7
Z	KM	0	9	2.2	1	46.2	2.2
W	Kshs	0	2.5	0.6	0	60.4	0.8
X	"	0	99	15.1	0	81.1	32.5
C	"	30	99	84.8	80	30.2	12.8
L	Acres	1	25	6.5	2	19.3	5.5
N	"	1	18	4.4	2	25.5	3.4
Q1	Bags	7	350	74.7	100	7.5	73.0
Q2	Bags	0	20	3.4	2	21.7	3.7
S1	"	0	300	54.4	0	19.8	63.9
S2	"	0	9	1.2	0	61.3	2.0
V1	Kshs	0	500	156.3	199	23.6	87.3
V2	"	0	900	158.3	0	61.3	210.7
Y	"	100	7000	1631.1	600	43.9	1399.1
G	Months	0	1.0	0.02	0	981.1	0.137
B1	Kshs	4	28	6.7	6	67.0	3.4
B2	"	4	45	9.5	9	31.1	5.2
D1	Dummy	0	1	0.5	-	-	0.51
D4	"	0	1	0.9	-	-	0.29
D5	"	0	1	0.1	-	-	0.23
D7	"	0	1	0.4	-	-	0.48
D8	"	0	1	0.1	-	-	0.35

Only 4.7% of the sample had received University education.

Examining the table further, we notice that most families had a family size of 8 people; the highest family size being 24 whereas the lowest comprised only one person representing 0.9% of the sample. The survey further revealed that the average time farmers used a tractor for ploughing (T1) is 4.3 hours. This result shows how small their farms are. This time becomes even less when we consider the duration that a tractor is used for re-ploughing (T2). The results suggest that 43.7% of farmers do not re-plough their farms by tractor but still the majority of those who do re-plough their farms use the tractor for this service for an average of 3 hours. One possible explanation to this fact may be that most farmers exhaust their income during ploughing and therefore their ability to pay at the time for re-ploughing is low since most of them have a monthly income (Y) of only Kshs. 600, representing about 35% of the sample size.

A further look at table 5.2.1 reveals that 54.% of the sample survey did not use the tractor for transport (T3). Since the mean value of tractor time spent on transportation is approximately 3 hours, there is a high possibility that most farms are located near homesteads or an alternative means apart from tractor service is used for transportation.

Turning to the demand for a tractor for shelling (T4), it was observed that 53.3% of the sample survey had used tractors for this purpose since 46.2% did not use it. The high percentage of those who did not use tractors for shelling maize is possible due to substitution of human labour for tractor for shelling. Most families could use their family members which seem to be relatively high averaging to 9.1 persons per family.

Most of these families are poor (see below). The survey also revealed that less than 50% of the farmers use tractors for other activities for example hurrowing, planting and spraying. The trable above shows that, the amount of tractor time demanded for other activities (T5) on average is 2 hours. These results suggests that this category of tractor services are not so important to the farmer as compared to the first four-infact many farmers said that they hurrow and plant mostly using human labour and in very few occassions use oxen.

A close examination of hire charges of various tractor services (P1 to P5) the results suggest that there is a great variation (see various standard deviations). On average, farmers pay Ksh 229 as the hire charge for tractor per hour for ploughing. The maximum amount being 520 and the m most common charge is K h 250. Charges for re-ploughing seems to be more reasonable as compared to those charged for ploughing. The average charge for this service is shs. 158. But those for transportation (P3) varied agreat deal giving arange of Kshs. 320, though on average farmers only pay about Ksh 44 per hour in order to utilise a tractor for transportation. P4 and P5 show avery high dispersion as indicated by the table. On average farmers pay sh. 73 and 84 for using the tractor for shelling and other activities respectively.

Table 5.2.1 further reveals that 46.2% of the farmers obtain tractors from a distance (Z) of about one kilometer away from their homes. This factor may motivate most of them to use tractors since these results suggests that the supply of tractors in Trans-Nzoia is high. Infact on average most farmers obtain tractors from a radius of only 2.2 km away from their farms. Dummy variable (D7) suggests that only 40% of smallholders had farm employees who infact receive an average hourly wage (W) of about 60 cents and the highest paid farm employee get Shs. 2.50. These results therefore

suggests that the average monthly wage of farm employees in Trans-Nzoia is Kshs. 108. This seems to be a very low wage rate and one possible explanation to this may be the low earnings ability of farmers. Turning to land acreage (L), the survey revealed that most families have only 2 acres of land which is possibly again devoted to farming (N) since the modal land portion devoted to farming is again 2 acres. But the average acreage is 6.5 acres.

The results also indicates that the mean number of bags of maize produced (Q1) by every family is 74.7, from this an average of 54.4 bags are sold (S1) at an average of sh 156.30 (V1). The most frequent selling price of maize per bag as indicated by the table is sh 199. This price corresponds to the price which the National Cereals and Produce Board was paying farmers during the period of study hence we can conclude that most farmers in Trans-Nzoia sell their maize to the Board.

The table also shows that the amount of beans produced by various families (Q2) had a small variation with a standard deviation of about 3.7 on average, most families produce 3.4 bags. From these, they sold an average of 1.2 bags (S2). The maximum selling price per bag being shs 900. But 61.3% of the farmers did not sell their beans in that season; those who sold could only afford to put a maximum of 9 bags on the market.

The Monthly income (Y) variation was expected. Our survey revealed that there is a big income variation among smallholders in the district. The highest recorded monthly income was shs 7,000 and only 0.9% of the sample was getting it.

The majority of the farmers only earn shs 600 a possible source of this income could be milk selling.

Finally, data in table 5.2.1 suggest that 98.1% of the small scale farmers whom we interviewed had not received any agricultural training (G). Infact the few that had received it had attended various courses lasting for a maximum of one month.

5.3 Estimation Results

Complementary to the above description pattern of various perameters, a further statistical analysis of the postulated determinants of tractor services was undertaken by estimating the various demand functions for different tractor services. This exercise was found particularly important because, for purpose of economic planning, it is of interest to be able to predict the effects of a change in any of the explanatory variables on the level of tractor hours demanded. The data used in estimating the demand functions were the same as that used in descriptive analysis in the last section.

Koutsoyiannis (1977) presents the criteria for accepting or rejecting the estimates:

> "In any econometric research, once the model has been estimated, we should proceed with evaluation of the estimates i.e. we should decide on acriteria whether the estimates of the parameters are theoretically meaningful and statistically satisfactory ....." (P:11)

In this study, the reported results were selected on the basis of the following criteria:

(1) Economic criteria, which are determined by the principles of economic theory and here we considered

(a) Correct Signs
(b) Size of the parameters of economic relationship

(2) Statistical criteria, which is used in assessing the relieability of the parameter estimates and here we considered

(a) Coefficient of multiple determination (R^2)
((b) The standard errors of estimates
(c) The related t - statistics.

(3) Correlation Coefficients between explanatory variables: See appendix 3.

Several regressions were estimated during the analysis, and these included:

(i) Regression analysis for the whole district
(ii) Regression analysis for individual divisions i.e. (a) Cherangani
(b) Kwanza
(c) Saboti
(iii) Regression analys for 2 divisions treated as one area.

But in this chapter, we only present and discuss regression results for the use of tractor services in Trans-Nzoia district in tables 5.3.1 to 5.3.5. The rest of the results are attached as appendix 2.

The model which was used with our data is given by equation (ii) of chapter 3, however few alterations were made to this model by the introduction of dummy variables and also interaction of some of the explanatory variables to find out their "joint effect," as a result the functional form of the estimating equation was specified in the form as:

$$\text{In } T_{ij} = A_o + \sum_{K=1}^{N} B_k \text{ In } X_k + \sum_{n=1}^{9} B_n Dn$$

$$+ \sum_{t=1}^{16} B_t \, Mt + E_{ij} \quad \ldots\ldots\ldots (i)$$

Where

T_{ij} = the tractor hours that farmer i requires of type (service) j

A_o = Intercept , $(A_o = \text{In } A_1)$

B_k = Parameters to be estimated

X_k = general form of all explantory variables described in table 5.1

E_{ij} = Stochastic error term

i = 1,2,..... 106 sample observations (farmers)

j = 1,2 ..... 5 (tractor services)

k = 1,2,.....N explanatory variables

n = 1,2,.....9 Dummy variables

t = 1,2,..... 16 interacted variables

B_n = dummy variable parameters

B_t = interacted variable parameters

In = natural logarithm

Ordinary least square (OLS) technique was used to estimate the coefficient estimates of the above equation. We now present the regression results based on the above information. The estimated coefficients for various parameters, as well as their R^2 contribution to the overall coefficient of determination are shown in the tables. Also the t ratio are presented; a stari sks donates that the relevant explanatory variable is stati stically significent at the 5 percent level; using a two tailed t test.

TABLE 5.3.1

Regression Results for the use of Tractors For Ploughing

Dependent Variable: LN(T1) = Time in hours, the tractor was used for ploughing

Regressor	Coefficient Estimate	R^2 Change	t - Statistic
L	0.5925	0.6116	8.58*
P1	0.1468	0.0710	4.18*
D7	0.2243	0.0125	2.11*
A	0.2603	0.0115	1.63
Y	0.0698	0.0063	1.43
W	0.1456	0.0034	1.17
D3	- 0.0866	0.0019	0.92
X	0.0168	0.0006	0.56
D1	-0.0411	0.0006	0.46
M4	-0.0085	0.0006	0.35
C	-0.0855	0.0005	0.37
Z	-0.0119	0.0001	0.17
Constant	0.4368	-	-

R^2 = 0.7205

D.F = 93

Source: Field Data, 1989

TABLE 5.3.2

Regression Results for the use of Tractor for Re-Ploughing

Dependent Variable : LN(T2) = Time in hours, the tractor was used for Re-ploughing

Regressor	Coefficient Estimates	R^2 Change	T - Statistic
P2	0.1660	0.5728	10.12*
N	0.4834	0.1873	6.61*
W	0.1786	0.0050	1.48
B1	0.1555	0.0038	1.14
D6	0.0689	0.0011	0.75
D8	0.2707	0.0009	0.74
M7	-0.1092	0.0033	1.48
M6	0.0975	0.0027	1.05
D7	0.0472	0.0004	0.45
Y	0.0159	0.0003	0.35
D1	0.0108	0.0001	0.14
Constant	0.6897	-	-

R^2 = 0.7776

D.F = 94

Source: Field Data, 1989

TABLE 5.3.3

Regression Results for the use of Tractor for Transport

Dependent Variable: LN(T3) = Time in hours the tractor was used for Transport

Regressor	Coefficient Estimates	R^2 Change	t-Statistic
P3	0.1894	0.4529	5.37*
Q1	0.3221	0.1012	3.19*
Y	0.1468	0.0182	2.18*
D7	0.2224	0.0128	1.34
Z	0.1593	0.0098	1.55
F	0.1625	0.0073	1.26
D1	-0.0650	0.0008	0.45
M15	0.0056	0.0005	0.32
M13	0.0006	0.0001	0.17
V1	0.0058	0.0001	0.16
Constant	0.4046	-	-

R^2 = 0.6038

DF = 95

Source: Field Data, 1989

TABLE 5.3.4

Regression Results for the use of Tractor for Shelling of maize

Dependent Variable: LN(T4) = Time in hours the tractor was used for Shelling of maize

Regressor	Coefficient Estimates	R^2 Change	t-Statistic
P4	0.2195	0.6734	7.25*
Q1	0.1922	0.0306	2.41*
W	0.2835	0.0088	2.10*
Y	0.0656	0.0085	1.32
F	0.1194	0.0041	1.3
M3	-0.0315	0.0026	1.2
D1	0.0719	0.0016	0.76
M2	0.0109	0.0016	0.73
V1	0.0028	0.0000	0.1
Constant	0.2442	-	-

R^2 = 0.7312

D.F = 96

Source: Field Data, 1989.

TABLE 5.3.5

Regression Results for the use of tractor for other activities

Dependent Variable: LN(T5) = Time in hours, the tractor was used for other activities

Regressor	Coefficient Estimates	R^2 Change	t-Statistic
P5	0.1859	0.5922	8.30*
N	0.3862	0.0665	4.73*
D1	-0.1426	0.0095	1.37
M7	-0.0177	0.0054	1.23
M16	-0.0475	0.0031	0.87
A	0.0995	0.0020	0.48
F	0.0333	0.0003	0.3
M14	0.0061	0.0002	0.27
Constant	0.3432	-	-

R^2 = 0.6793

D.F = 97

Source: Field Data, 1989.

5.4 Discussion of Regression Results

In the previous section, the estimated results were presented. We now discuss these results based on tables 5.3.1 to 5.3.5. On the basis of the statistical results presented in these tables, we can further present these estimated results in equation form as follows:*

Equation 1 = A representation of use of tractor for ploughing as given by table 5.3.1

$\ln T1_i$ = 0.44 + 0.59 In L ; 0.15 In P1 + 0.22D7 + 0.07 In Y + 0.15 In W - 0.09 D3 + 0.02 In X - =.04D1 - 0.01M4 - 0.09In C - 0.01 In Z

Equation 2: = A representation of the use of tractors for re-ploughing as given by table 5.3.2

$\ln T2_i$ = 0.69 + 0.17 In P2 + 0.48 In N + 0.18 In W + 0.16 In B1 + 0.07 D6 + 0.27 D8 - 0.11 M7 + 0.1 M6 + 0.05 D7 + 0.02 In Y + 0.01 D1

Equation 3: = A representation of the use of tractor for Transport as given by table 5.3.3

$\ln T3_i$ = 0.4 + 0.19 In P3 + 0.32 In Q1 + 0.15 In Y + 0.22 D7 + 0.16 In Z + 0.16 In F - =.7 D1 + 0.01 M15 + 0.001 M13 + 0.01 In V1

Equation 4: = A resentation of the use of tractors for shelling as given by table 5.3.4

$\ln T4_i$ = 0.24 + 0.22 In P4 + 0.9 In Q! + 0.28 In W + 0.07 D + 0.07 In Y + 0.12 In F - 0.03 M3 + 0.01 M2 + 0.00 In V1

Equation 5 = A representation of the use of tractors for other activities as given by table 5.3.5

$$\ln T5_i = 0.34 + 0.19 \ln P5 + 0.39 \ln N - 0.14 D1 - 0.02 M7 - 0.05 M16 + 0.1 \ln A + 0.03 \ln F + 0.013 M14$$

Where

* indicates that the coefficient estimates in tables 5.3.1 to 5.3.5 have been corrected to the nearest 2 decimal places

i, is an individual farmer, i = 1,2.....n

For explanatory variables see table 5.1

The interpretation of the various coefficient estimates needs further discussion. As indicated by "equation 1 above and table 5.3.1, the land acreage (L) regression Coefficient is positive and is statistically significant at the 5% level indicating that more tractor hours will be demanded for ploughing purposes the larger the farm size. The regression Coefficient of the land variable is given as 0.5925, hence according to this result, if a farmer acquires an additional land acreage of 10% his demand for tractor hours will increase by approximately 6%; other factors being held constant. Its possible for a farmer to increase his land acreage by "renting and also through buying." The above results on land variable are even strengthened when we consider the portion of farmer's land which was devoted to farming in the last season (N)[1]. According to equation 2 and table 5.3.2 the coefficient estimate of N is given as 0.4834; indicating that a one percent change in the portion of land under farming would lead to a 0.48 percent change in demand for tractor for re-ploughing.

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1. Last season here means the period 1988

It can be seen that it is statistically significant and it accounts for about 19 percent in the variation of tractor hours used for re-ploughing.

The contribution of the tractor hire charges (P1 to P5) towards tractor utilisation requires a lengthy analysis. The results indicates that there is a direct statistically significant relationship between the price that farmers pay in order to use a tractor and the amount of tractor hours that they actually use. This result may be due to the fact that the tractor services in Trans-Nzoia are so necessary [2] and therefore they are essential or, during the peak season when tractors are required for various activities, farmers normally have no other alternative but to pay the price which the "tractor contractors" suggest to be appropriate. Farmers main aim for example may be to (that he) prepare his land on time or shell his maize at the right time before the rains come; this could make him pay any amount in order to use a tractor. An alternative to various tractor services could be oxen (D8) but as we shall show later, one of our findings was that more than 82% of the farmers had not even used oxen at all for any farm activity. These results made us to make the following three conclusions:

1. That either there are no enough oxen in the district and therefore they can not satisfy the local demand. A view which was shared by some of the farmers. Or
2. That farmers have already become acquainted to using tractors.
3. Keeping oxen requires more land.

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2. "..... but if there are no good substitutes, the extent to which the commodity is necessary may affect the elasticity of demand for it." (Hanson 1978: 197)

Therefore, basing our argument on the above conclusions, there is a possibility of farmers paying any price for tractor services to see that they utilise the services. Secondly, the tractor services providers might have already acquired "amonopolistic power" since they might be aware that they provide essential and necessary services with limited close substitutes and lastly, all the tractor services considered in this study have elasticity of demand of less than unity (approximately 0.2) hence these tractor services can be termed as being price inelastic (see 5.5). Given these results, a fairly considerable change in price of tractor services makes little difference on the quantity of tractor hours demanded. The above described factors may lead to this direct relationship between tractor hire charges and the tractor hours used.

Abrief examination of various hire charges and the quantity of tractor hours demanded as contained in tables indicate that on average there is avery small additional variation (of about 0.2%) in tractor hours utilised as the tractor hire charges increase by 1%. Take ploughing as an example, table 5.3.1 indicates that as the hire charge of tractors for ploughing increases by 1% tractor utilisation seems to increase by 0.15%, the results being statistically significant at the 5% level. The price contribution to the R^2 is 0.071 implying that it only accounts for 7.1% in the variation of tractor hours for ploughing, ceteris peribus. These results suggest that though price of tractors are statistically significant at 5% level, other factors are more important than price because they contribute a larger proportion of the overall R^2.

The dummy variable coefficients are additive to the autonomous term, each representing the different effect of the corresponding dummy variable on the tractor hours demanded. Dummy variable D7 assumes avalue of one if the farmer has farm employees and zero otherwise. A look at tables 5.3.1 to 5.3.3 reveals that D7 has a positive influence on demand for tractor services namely ploughing, re-ploughing and transport. But though D7 is statistically significant at 5% for ploughing, it is not significant for other tractor services. The intercept for the ploughing equation will increase by 0.2243 if a farmer has farm employees and in general, the positive relationship between this dummy variable and the demand for the three named services may be due a result of farmers not using their farm employees as a substitute for tractor but deploying them elsewhere for example to look after cattle.

The contribution of the age (A) variable towards tractor demand is virtually not statistically significant at the 5% level. Though age accounted for 1.2% in the variation of tractor hours for ploughing and about 0.2% for other activities age came out as not being a good explanatory variable for tractor hours demanded. The positive relationship between (A) and quantity of tractor hours demanded could be an indication that old farmer have more experience on tractor utilisation than young ones.

Other explanatory variables which seem not to be good regressors due to their statistical insignificence include the family size, the selling price of products produced using tractor services; the quantity of products sold and lastly all the interacted variables (M1 to M16)[3].

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3. See the t-statistic column of table 5.3.1 to 5.3.5.

Monthly personal income of farmer (Y) has a positive and in some cases a significent impact on the use of tractor services. Table 5.3.1 gives the income regression coefficient as 0.0698, a result which indicates that if farmers monthly income increase by 10%, his use of tractors for ploughing purposes will go up by approximately 0.7% but this coefficient is not statistically significent at the 5 percent level; hence Y's contribution to tractor demand is vividily not important at all. These statistical results confirms what was experienced during data collection that many farmers income earnings was low[4] and infact some of them had no alternative sources of income apart from farming. The foregoing situation led us in making a deduction that the amount of money that farmers spent on ploughing by using tractors is possibly a saving from the previous seasons' earnings; therefore it is obvious from these that there is very little dispersion in the overall farmers level differentials.

Coming to the utilisation of tractors for transportation, variable (Y) is positive and statistically significant at the 5 percent level indicating that a farmer will prefer more tractos to less as his income level raises. A closer examination of table 5.3.3 reveals that income accounts for 1.8% in total variation of tractor hours for transportation.

Finally, our results show that the contribution of wage rate to the demand for all the tractor services investigated is virtually not statistically significant, apart from the shelling service.

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4. See the descriptive Statistics.

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Table 5.3.4 gives the wage rate regression coefficient as a 0.28 percent variation in the demand for tractor hours will also lead to a one percent change in the hourly labour wage rate. This result truely reflect what takes place during the shelling of maize process. During maize shelling a tractor and human labour are complementary. A farmer whose maize is being shelled has the responsibility of employing his own labour force which is required for the following activities:-

(i) Transporting maize from the granary to the shelling point and back to the store after shelling.

(ii) Filling the bags with maize and empting them into the tractor sheller.

(iii) Removing the maize cobs from the shelling point.

The above activities should be done within the shortest time possible in order to minimise wastage of tractor time [5].

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5. Author's experience during the time of data collection.

5.5 Estimated demand elasticities for various tractor services

The two foregoing sections give an illustration and interpretation of various Coefficient estimates as they influence tractor hours demanded by farmers. In this section, we now give a brief summary of income and price elasticities in order to show more clearly the sensitivity of tractor hour changes as a result of a change in both the service hire charges and farmers income (Y). We gave our estimating equation in Chapter 3 as:

$$\text{In } T_{ij} = A_o + B_i \text{ In } P_i + B_j \text{ In } W + B_k \text{ In } Y + ... + E_{ij}$$

The partial derivative of the function with respect to the price P_i is

$$\frac{\partial \text{ In } T_{ij}}{\partial \text{ In } P_i} = B_i$$

Whereas the one with respect to income (Y) is

$$\frac{\partial \text{ In } T_{ij}}{\partial \text{ In } Y} = B_k$$

From the basic propety of logarithms, a change of the logarithm variable is normally equal to the proportionate change of the variable [6]. Applying the above partial derivative we obtain:

$$d \text{ In } T_{ij} = \frac{dT_{ij}}{T_{ij}} \quad \text{and}$$

$$d \text{ In } P_i = \frac{dP_i}{P_i}$$

---

6. See: Modern Economics by A Koutsoyiannis P 54.

and by substitution we have

$$\frac{d\,In\ T_{ij}}{d\ In\ P_i} = \frac{d\ T_{ij}}{T_{ij}} \Big/ \frac{dP_i}{P_i} = B_i$$

Hence the log linear representation entails that the Coefficient estimates of parameters are elasticities. Therefore in the above formulation B_i is the price elasticity of demand for tractor services and B_k is the income elasticity of demand for these services.

We now present the estimated income and price elasticities for the investigate tractor services:

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TABLE 5.5.1

Estimated Demand Elasticities for tractor services for Trans-Nzoia, 1989

Category of Tractor Service	Price Elasticity	Income Elasticity
Ploughing	0.1468	0.0698
Re-Ploughing	0.1660	0.0159
Transport	0.1894	0.1468
Shelling	0.2195	0.0656
Other activities	0.1859	n.a.

n.a = elasticity not computed

Source: Field Data (1989)

Table 5.5.1 shows the proportionate change in various tractor services given a unit proportionate change in both price and income levels, all other parameter being held fixed. The results indicate that the demand for the tractor services in Trans-Nzoia district are both price and income inelastic since the Coefficient estimates for these two parameters is less than unity. These tractor services also exhibit a positive income elasticity and therefore no service is inferior. Rounding the values of price elasticity to one decimal place gives all the elasticities as 0.2. Though no tractor service can be termed as being inferior, income's influence on demand for these services is low. Take for example income eleasticity of demand for the ploughing category, a 10% increase in monthly income will only lead to a 0.7% increase in tractor hours demanded for ploughing.

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5.6 Hypotheses Testing

This section pays a brief attention to the hypotheses that were specified in Chapter three. Koutsoyiannis' (1977, p 561) procedure for a hypothesis testing concerning the value of a population parameter was adopted in this study.

Our hypotheses in section 3.2 of Chapter 3 can be stated in general form as follows:

$$H_o : B_i = 0$$

$$H_i : B_i \neq 0$$

$$i = 1,2,.....K$$

The null hypothesis (H_o) specified above indicates that all the Coefficients in the model are zero implying that the corresponding independent variable exerts no statistical significent linear influence on tractor hours demanded (dependent variable). Whereas the alternative hypothesis (H_i) denotes the counter proposition of the null hypothesis.

In this study the level of significance was fixed at 5% and a two-tailed t_test was conducted. This type of test was chosen due to the form of our alternative hypothesis was expressed.

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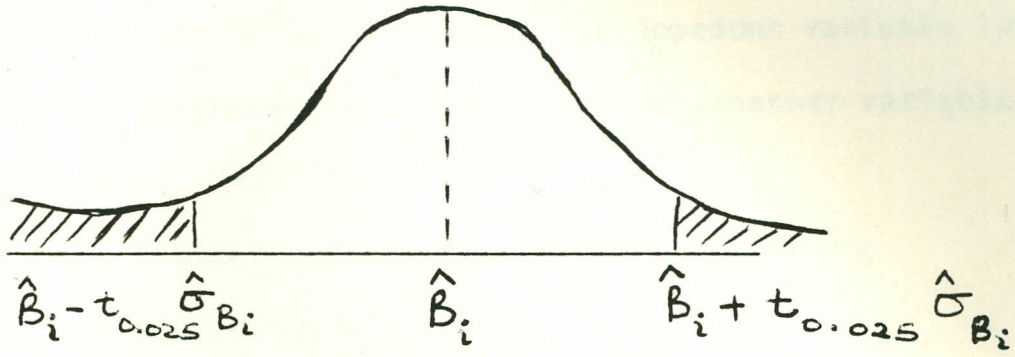

The critical region was set at

$t_{0.025} = \pm 2.093$ with n - k degrees of freedom

where

n = Sample Size

k = number of regressors in the equation.

t - statistic was then computed from the observed sample using the formula.

$$t^* = \frac{\hat{B}_i}{\hat{\sigma}_{B_i}}$$

Thus the t* ratio is the ratio of the estimated regression Coefficient to its standard error.

This t* ratio was compared with the theoretical (tabular) t - value that defines the critical region. In general, the null hypothesis was accepted if the absolute value, $|t^*| < 2.093$ and rejected when $|t^*|$ exceeded this value.

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A low t - value implies that the Coefficient is not statistically significant, in that the depedent variable is not linearly dependent on the relevant explanatory variable: (Intrilligator 1978: 130).

Below is the tabular presentation of the hypotheses specified in section 3.2.

TABLE 5.6.1

Hypothesis Testing for Various estimated Coefficients **

Variable	Coefficient Estimate	Std Error	t* ratio	Remarks
P1	0.1468	0.0351	4.18	Reject null hypothesis
P2	0.1660	0.0164	10.12	"
P3	0.1894	0.0353	5.37	"
P4	0.2195	0.0303	7.25	"
P5	0.1859	0.0224	8.30	"
Q1	0.3221	0.1010	3.19	"
L	0.5925	0.0691	8.58	"
N	0.3862	0.0816	4.73	"
M15	0.0056	0.0175	0.32	Accept null hypothesis
X	0.0168	0.03	0.56	"
B1	0.1555	0.1364	1.14	"

** the Coefficient estimates are those in tables 5.3.1 to 5.3.5

Source: Field Data (1989)

Based on data in table 5.6.1 we can make the following conclusions concerning our hypotheses in section 3.2 of Chapter three; at the 95% level of confidence that:

1. There exists a direct statistical significant relationship between tractor hours utilised and the hire charge for all tractor services.

2. There is a clear positive relationship between the amount of maize produced by farmers (Q1) and the utilization of tractor for shelling purposes. But the "case was not proven" as far as tractor utilization for transportation is concerned (M15).

3. There is a positive statistical significant impact of land acreage (both L and N) on the tractor hours demanded by a farmer for ploughing and re-ploughing.

4. There exists no statistical significent relationship between the price of other farm inputs for example oxen and fertilizer and the demand for tractor services.

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CHAPTER SIX

SUMMARY, CONCLUSIONS AND POLICY IMPLICATIONS

6.1 Summary and Conclusions

The present study was designed to investigate into the factors that affect the demand for tractor services among the smallholders in Trans-Nzoia district. The investigator hence made an attempt to analyse the socio-economic factors that he postulated as being the main determinants of the use of tractors and made his conclusions on the basis of the statistical results.

In chapter 1, an overview of the background to the study is presented. In this background, the importance of the agricultural sector to the Kenyan economy, the role of the small farm sub-sector and finally the extent to which tractors are used in Kenya are briefly discussed. A deducton of the statement of the research problem is made from this background; which is later followed by a presentation of the objectives and significance of the study.

The literature review described in chapter suggests that there has been very little empirical studies on this topic in Kenya. Most of the past studies and theoretical considerations focused on the general relationship between mechanisation and the level of employment and that they were carried out only on large farm sub-sector. There is hençe a justification for this study which considers the small farm sub-sector.

A critical review of these past studies was made in this chapter bringing out both their weaknesses and srength and also showing how the current study links and deviates from those earlier studies.

In chapter 111 a theoretical analytical framework for the postulated determinants of demand for factor services is derived. The chapter also considers the broad hypotheses to be tested in chapter V.

Chapter 1V is devoted to the study design. In this chapter, a discussion on data collection and analysis, a brief overview of the study area (Trans-Nzoia district) are examined and finally the sampling techniques used is presented.

Chapter V presents the empirical findings of this study. Thus based on these empirical evidence, it can be concluded that:-

1. There is an evidence of strong positive correlation between acreage and use of tractors (table 5.6.1). This result suggest that people with large farms will tend to use more "tractor hours" as compared to subsitutes such as ox-drawn ploughs.

2. The researcher's empirical investigation show that the variation in income levels apparently is weakly associated with demand for various tractor services in Trans-Nzoia

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He therefore suggests that this weak association between income variation and use of tractors might be a reflection of the low income levels of the smallholders. A great deal of empirical evidence suggest that the average monthly income of small holders in Trans-Nzoia is about Kshs 600 and that about 35% of the sampled population was receiving it; whereas the hire charge of a tractor ploughing an acre is about Kshs 260 and besides hiring tractors, farmers buy hybrid maize seeds which was being sold at Kshs 106 for a 10 kg bag without transport considerations, fertiliser mainly Di ammonium phosphate (DAP) which was being sold at Kshs 294.60 for a 50 kg bag and many others.
Clearly, the analysis of all these costs show that smallholders might not have much left to spend on tractor services at any given instant.

Regression analysis indicate that there is a direct relatonship between the tractor hire charges and the amount of tractor hours that a farmer utilises: This possibly suggest why many small holders[1] only utilise tractors for ploughing; and use fewer tractor hours for other services.

Given the major objectives of the study in chapter 1, the following concluding remarks can also be made as deducted from a great deal of the empirical evidences.

1. That there is no government tractor hire service sheme in Trans-Nzoia district and therefore the main tractor service providers are the private contractors.

2. Tractor service utilisation in the district as for the 1988-89 period can be presented as follows:

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1. The study revealed that 92.5 per cent of the smallholders had used tractors for ploughing

TABLE 6 .1

Percentage of tractor service utilisation in Trans-Nzoia in 1988-89 season:*

Category of tractor service	% of the farmers who used tractor for the service
Ploughing	92.5
Re-ploughing	56.6
Transport	45.3
Shelling	53.8
Other activities	44.3

* computed results

source: Field Data 1989

The empirical evidence as illustrated by table 6.1 suggest that ploughing is the most important tractor service which smallholders utilise. 92.5 per cent of the respondents had used tractors for ploughing in the 1988-89 season. But when it came time to re-plough, only 56.6 per cent employed tractors for this activity. A fall from 92.5 to 56.6 per cent in the tractor usage could be a result of the low ability to pay for this tractor service. As it was indicated in the descriptive statistics most farmers have an average monthly personal income (Y) of ksh. 600, hence there is a possibility of some smallholders exhausting their incomes at the time of ploughing and therefore being left with barely enough to spend

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on re-ploughing. This evidence is infact revealed more in table 6.1 which shows that only 44.3 per cent of the smallholders could afford to employ tractors for other activities.[2] These activities are demanded within a very small range of time after ploughing.

Table 6.1 also show that 45.3 per cent of the smallholders used tractors to transport farm outputs from farms to their homes. The results also indicate that slightly more than 50 per cent of the smallholders used tractors for maize shelling. The study also showed that about 80 per cent of the smallholders had sold their 1988 produce (S1) . These results could imply that smallholders use tractor shellers in order to speed up the process of maize shelling and be able to sell their maize on time.

In Trans-Nzoia, maize harvesting is done from November to January while ploughing is done immediately after harvesting in preparation for the next planting season. Since smallholders have low income and few sources of generating it (see the concluding remark 1 below), they find it worthwhile to speed up the process of shelling their produce so as to generate the funds needed for ensuring ploughing season. This then explains the increased use of tractors for shelling as comparing to the last two tractor services mentioned above.

In addition to the above concluding remarks, it was also found out that:

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2. Other activities here mean harrowing, planting and spraying

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1. 64.2 per cent of the smallholders take farming as their main occupation.

2. About 40 per cent of the smallholders had farm employees.

3. Only 17.9 per cent had used oxen for farm operations. This result suggest the inadequacy use of oxen in the district. The investigator has the view that ox-ploughs could be used as an alternative to tractors for farm operations by smallholders; but at present they are not being used much because they are scarce in smallholders farm areas in Trans-Nzoia. One reason of their scarcity may be the relative small size of farms which do not condusively allow oxen keeping.

4. Approximately all smallholders in Trans-Nzoia (about 98.1%) have not received any form of agricultural training.

5. All small farm holders in Trans-Nzoia whom the investigator interviewed apparently had used Di ammonium phosphate (DAP) and also hybrid maize seeds. This then shows that agriculture in trans-Nzoia has to been transformed from tradiltional type to modern.

6.2 Policy Implications of the study

Based on the empirical evidences of this study, the investigator

suggests the following policy measures.

1. There is a need for the Ministry of Agriculture to introduce the Government tractor hire service scheme in Trans-Nzoia district, which, otherwise is lacking, in order not only to take the advantage of the tractor hire charges factor but also to bring competition in terms of tractor service provision with a view of easing price differentials.

2. Oxen could be used as a substitute for tractors given the relative size of smallholder farms, but our empirical results in the descriptive statistics indicate that most[3] smallholders in Trans-Nzoia district have 2 acres of land on average; hence keeping oxen would mean a further reduction of the already small farms: unless zero grazing method is used.

   We suggest that more appropriate farm impliments which could possibly lead to a more profitable situation in the small farm sub-sector in Trans_Nzoia should be used instead of relaying heavily[4] on tractors. This calls for more research in scientific and Technological progress(STP)

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3 The term "most" here has the same meanings as "made"

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4. The study revealed that 92.5 percent of the farmers used tractors for ploughing.

6.3 Suggestions for further Research

There are some questions which still need to be answered as far as tractor utilisation on small farms is concerned, and in view of this, the investigator recommends the following for further research:

1. There is a need to investigate the extent to which tractors are used on small farms in other Kenyan districts so that the results could be compared to find out their economic viability.

2. A great deal of research is required to identify and evaluate factor - factor combinations between tractors and other farm inputs on small farms in Trans-Nzoia district with a view of illustrating the degree of profitability of small holders as a result of tractor utilisation.

3. Further to our second recommendation on policy measures above on appropriate farm implements; there is a need of more research on the subject with a view of determining the most appropriate farm implements which can be employed by smallholders.

APPENDIX 1

QUESTIONNAIRE

SURVEY OF TRACTOR USER

CHARACTERISTICS

IN TRANS-NZOIA DISTRICT

QUESTIONNAIRE NO .....

DATE OF INTERVIEW.....

GREETINGS:

We are carrying out a study on demand for tractor services in Trans-Nzoia District. We are interested in talking to farmers who use tractors. The results of this study will be shared with tractor service providers and it will help them to improve their services. We are not recording your names. We would be grateful if you could answer the following questions.

QUESTIONNAIRE

1 (a) Division .....

(b) Location .....

(c) Sub-location .....

(d) Sex

1. Male ( )
2. Female ( )

2. How old are you? .....(years)
3. What is your education level .....
4. What is your family size .....
5. What is your main occupation .....
6. Did you use a tractor in the previous season?
   1. Yes
   2. No

If no, why

(1) .....

(2) .....

(3) .....

If yes,

(a) What did you use the tractor for?

(i) .....

(ii) .....

(iii) .....

(iv) .....

(v) .....

(vi) .....

(b) For how long did you use a tractor ?

Activity	Duration in Hours, days
(i) ----------	.....
(ii)	.....
(iii)	.....
(iv)	.....
(v)	.....
(vi)	.....

(c) How much were you charged per hour/day

Activity	Charges, day/hour
(i) ploughing	.....
(ii)	.....
(iii)	.....
(iv)	.....
(v)	.....
(vi)	.....

7. Why did you decide to use a tractor?

(i) .....

(ii) .....

(iii) .....

8. From where did you obtain the tractor?

   (i) Place .....

   (ii) Distance in Km .....

9. Do you have farm employees?

   1. Yes

   2. No.

   (a) If yes, how many ?.....

   (b) What is their wage rate per hour/week/month?

10. Name any other farm implements you used and their charges:

Implements	Activity	charges/hour,day acre
(i) Oxen	Ploughing	----------
(ii)	.....	.....
(iii)	.....	.....
(iv)	.....	.....
(v)	.....	.....
(vi)	.....	.....

11. (a) What is your land acreage .....

    (b) Portion of land under farming.....

12. Which crops did you grow in the last season?

    (i).....

    (ii) .....

    (iii) .....

13. What were your produce in the last season?

crop	Bags
(i)	.....
(ii)	.....
(iii)	.....

14. How much of the above did you sell and at what price?

crop	amount sold in bags/kg	price for bag/kg
(i)		
(ii)		
(iii)		

15. In case you have any other occupation apart from farming which of the following total monthly personal income categonises so you belong to:

1 ksh 0 - 200

2 ksh 201 - 1000

3 Ksh 1001 - 2000

4 Ksh 2001 - 3000

5 Ksh 3001 - 4000

6 ksh 4001 - 5000

7 ksh 5001 - 6000

8 ksh 6001 - 7000

9 ksh 7001 - and above - (specify)

16. Have you recieved any agricultural training

1 Yes

2 No

If yes

(b) (i) Place .....

(ii) Duration in months .....

17 Name any other farm input you used in the last season.

Name of input	Quantity	per unit (specify)
(i)	.....	.....
(ii)	.....	.....
(iii)	.....	.....

THANK YOU FOR YOUR

COOPERATION

APPENDIX 2
ADDITIONAL REGRESSION RESULTS

TABLE 8.1
REGRESSION RESULTS FOR THE USE OF TRACTORS FOR PLOUGHING IN CHERANGANI DIVISION

DEPENDENT VARIABLE : LN(T1)=TIME IN HOURS; THE TRACTOR WAS USED FOR PLOUGHING

REGRESSOR	COEFFICIENT ESTIMATES	R CHANGE	T-STATISTICS
L	0.9079	0.5627	6.75 *
P1	0.2418	0.0304	2.42 *
X	0.1322	0.0311	1.95
C	0.7298	0.0208	1.47
D5	0.4555	0.0121	1.09
A	0.1267	0.0115	0.84
D1	0.1114	0.0051	0.71
W	0.0824	0.0022	0.45
Z	0.0156	0.0022	0.12
CONSTANT	2.8835		

$R^2 = 0.6761$

D.F = 27

SOURCE : FIELD DATA; 1989.

TABLE 8.2
REGRESSION RESULTS FOR THE USE OF TRACTORS FOR RE-PLOUGHING IN CHERANGANI DIVISION

DEPEDENT VARIABLE: LN (T2) = TIME IN HOURS ; THE TRACTOR WAS USED FOR RE-PLOUGHING

REGRESSOR	COEFFICIENT	R^2 CHANGE	T-STATISTICS
N	0.6806	0.6446	5.73*
P2	0.1400	0.1926	6.21*
D1	-0.1881	0.0224	1.77
B1	0.2984	0.0169	1.97
M6	0.0387	0.0151	2.10
D7	0.0911	0.0021	0.64
D6	0.0483	0.0006	0.37
Y	0.0158	0.0002	0.76
CONSTANT	1.0153		

R^2 = 0.8962

D.F = 26

SOURCE : FIELD DATA; 1989.

TABLE 8.3
REGRESSION RESULTS FOR THE USE OF TRACTORS FOR TRANSPORT IN CHERANGANI DIVISION.

DEPEDENT VARIABLE: LN (T3) = TIME IN HOURS THE TRACTOR WAS USED FOR TRANSPORT

REGRESSOR	COEFFICIENT ESTIMATE	R^2 CHANGE	T-STATISTICS
P3	0.2225	0.5472	4.8*
Q1	0.4079	0.0379	2.92*
Y	0.2149	0.0625	2.27*
M15	-0.525	0.0366	1.64
F	0.1939	0.0180	0.95
D7	-0.3857	0.0157	1.58
Z	0.1838	0.0088	1.22
M13	0.0049	0.0097	0.95
D1	-0.0821	0.0028	0.51
V1	0.0068	0.0003	0.16
CONSTANT	0.1658	--	--

R^2 = 0.7397

D.F = 26

SOURCE : FIELD DATA , 1989.

TABLE 8.4

REGRESSION RESULTS FOR THE USE OF TRACTORS FOR SHELLING IN CHERANGANI DIVISION

DEPEDENT VARIABLE LN(T4) = TIME IN HOURS THE TRACTOR WAS USED FOR SHELLING

REGRESSOR	COEFFICIENT ESTIMATE	R^2 CHANGE	T-STATISTICS
M5	0.0428	0.6704	4.12*
Q1	0.3255	0.0476	2.28*
W	0.3280	0.0168	1.72
Y	0.1601	0.0214	1.59
D1	0.1658	0.0085	1.05
F	-0.1258	0.0044	1.05
V1	-0.0116	0.0006	0.71
M1	0.0069	0.0005	0.32
M3	-0.0129	0.0006	0.28
CONSTANT	0.3778	--	-

R^2 = 0.7709

D.F = 27

SOURCE : FIELD DATA ;1989.

TABLE 8.5

REGRESSION RESULTS FOR THE USE OF TRACTORS FOR OTHER ACTIVITIE IN CHERANGANI DIVISION.

DEPEDENT VARIABLE LN (T5) = TIME IN HOURS THE TRACTOR WAS USED FOR OTHER ACTIVITIES.

REGRESSOR	COEFFICIENT ESTIMATE	R^2 CHANGE	T-STATISTICS
P5	0.175	0.673	3.6*
N	0.503	0.048	3.03*
D1	-0.343	0.039	2.28*
F	0.176	0.012	1.05
M7	-0.070	0.009	0.55
M16	-0.058	0.009	1.14
M6	0.117	0.003	0.63
D8	0.576	0.001	0.32
CONSTANT	0.723	-	-

R^2 = 0.793

D.F = 28

SOURCE : FIELD DATA ; 1989 .

TABLE 8.6

REGRESSION RESULTS FOR THE USE OF TRACTORS FOR PLOGHING IN KWANZA DIVISION.

DEPEDENT VARIABLE : LN(T1) = TIME IN HOURS THE TRACTOR WAS USED FOR PLOUGHING.

REGRESSOR	COEFFICIENT	R^2 CHANGE	T-STATISTICS
L	0.497	0.529	3.85*
P1	-0.125	0.167	2.28*
X	-0.056	0.017	0.94
Z	0.242	0.005	1.03
Y	0.081	0.004	0.81
C	-0.314	0.000	0.57
M4	-0.019	0.000	0.23
W	-0.130	0.000	0.14
A	-0.048	0.0000	0.22
D1	0.023	0.000	0.1
CONSTANT	0.864	-	-

R^2 = 0.741

D.F = 25

SOURCE : FIELD DATA , 1989 .

TABLE 8.7

REGRESSION RESULTS FOR THE USE TRACTORS FOR RE-PLOUGHING IN KWANZA DIVISION

DEPEDENT VARIABLE : LN(T2) = TIME IN HOURS THE TRACTOR WAS USED FOR RE-PLOUGHING.

REGRESSOR	COEFFICIENT ESTIMATE	R^2 CHANGE	T-STATISTICS
P2	0.126		3.36*
N	0.357		2.53*
D1	0.251		1.05
M7	-0.133		0.79
D8	0.390		0.84
W	0.440		0.77
Y	0.094		0.75
M6	0.078		0.39
D6	0.060		0.25
B1	0.084		0.24
CONSTANT	0.498		--

$R^2 = 0.6722$

D.F = 25

SOURCE : FIELD DATA : 1989.

TABLE 8.8

REGRESSION RESULTS FOR THE USE TRACTORS FOR TRANSPORTATION IN KWANZA DIVISION.

DEPEDENT VARIABLE LN(T3) =TIME IN HOURS THE TRACTOR WAS USED FOR TRANSPORTATION

REGRESSOR	COEFFICIENT ESTIMATE	R^2 CHANGE	T-STATISTICS
P3	0.264	0.645	4.59*
Q1	0.100	0.027	0.71
D7	0.167	0.011	0.80
D1	-0.210	0.007	0.96
M15	0.028	0.010	0.69
F	0.077	0.001	0.35
M13	0.001	0.000	0.21
V1	0.007	0.000	0.15
CONSTANT	0.470	-	-

$R^2 = 0.702$

D.F = 27

SOURCE : FIELD DATA ; 1989 .

TABLE 8.9

REGRESSION RESULTS FOR THE USE TRACTORS FOR MAIZE SHELLING IN KWANZA DIVISION.

DEPEDENT VARIABLE : LN(T4) =TIME IN HOURS THE TRACTOR WAS USED FOR SHELLING MAIZE.

REGRESSOR	COEFFICIENT ESTIMATE	R^2 CHANGE	T-STATISTICS
P4	0.181	0.807	1.67
Q1	0.131	0.006	1.1
D1	-0.156	0.008	0.83
M5	-0.175	0.003	1.27
M4	0.040	0.004	0.62
M2	0.022	0.002	0.91
M1	0.019	0.002	0.60
V1	0.016	0.001	0.40
Y	0.024	0.001	0.31
W	-0.153	0.001	0.28
CONSTANT	0.576	-	-

$R^2 = 0.842$

D.F = 25

SOURCE : FIELD DATA ; 1989 .

TABLE 8.10

REGRESSION RESULTS FOR THE USE OF TRACTORS FOR OTHER ACTIVITIES IN KWANZA DIVISION.

DEPEDENT VARIABLE LN(T5) = TIME IN HOURS THE TRACTOR WAS USED FOR OTHER ACTIVITIES

REGRESSOR	COEFFICIENT ESTIMATE	R^2 CHANGE	T-STATISTICS
P5	0.169	0.515	3.97*
N	0.273	0.055	1.74
D8	-0.164	0.023	0.76
M16	0.027	0.005	0.18
A	0.125	0.002	0.36
F	0.065	0.001	0.28
M14	0.012	0.001	0.64
D1	0.036	0.000	0.47
CONSTANT	0.420	-	-

R^2 = 0.591

D.F = 27

SOURCE : FIELD DATA, 1989.

TABLE 8.11

REGRESSION RESULTS FOR THE USE OF TRACTORS FOR PLOUGHING IN SABOTI DIVISION.

DEPEDENT VARIABLE : LN(T1) = TIME IN HOURS THE TRACTO WAS USED FOR PLOUGHING.

REGRESSOR	COEFFICIENT ESTIMATE	R^2 CHANGE	T-STATISTICS
L	0.569	0.7302	5.09*
P1	0.119	0.0254	1.3
D1	0.287	0.0328	1.70
X	0.042	0.0097	0.73
Y	0.081	0.0074	1.0
W	0.207	0.0055	0.83
Z	0.043	0.0007	0.43
D5	-0.124	0.0014	0.39
A	0.051	0.0002	0.81
CONSTANT	0.900	--	--

R^2 = 0.8134

D.F = 23

SOURCE : FIELD DATA; 1989.

TABLE 8.12

REGRESSION RESULTS FOR THE USE OF TRACTORS FOR RE-PLOUGHING IN SABOTI DIVISION.

DEPEDENT VARIABLE : LN(T2) TIME IN HOURS ; THE TRACTOR WAS USED FOR RE-PLOUGHING.

REGRESSOR	COEFFICIENT ESTIMATE	R^2 CHANGE	T-STATISTICS
P2	0.236	0.758	6.84*
N	0.296)	0.072	1.92
D6	0.195	0.006	1.19
D1	0.253	0.008	1.73
W	0.424	0.006	0.96
D7	-0.235	0.005	0.76
B1	0.396	0.002	0.56
M7	-0.065	0.002	0.17
Y	0.019	0.001	0.20
M6	0.056	0.001	0.13
CONSTANT	0.211	-	-

D.F = 22

SOURCE : FIELD DATA; 1989.

TABLE 8.13

REGRESSION RESULTS FOR TFE USE OF TRACTORS FOR TRANSPORT IN SABOTI DIVISION-TRANS NZOIA

DEPEDENT VARIABLE :LN(T3) = TIME IN HOURS THE TRACTOR WAS USED FOR TRANSPOTATION

REGRESSOR	COEFFICIENT ESTIMATE	R^2 CHANGE	T-STATISTICS
Q1	0.566	0.495	1.82
P3	0.165	0.055	2.12*
V1	-0.129	0.032	1.05
M13	0.019	0.026	1.80
D7	0.736	0.034	1.46
M15	0.072	0.028	1.22
Y	0.242	0.026	1.35
F	0.120	0.003	0.46
D1	0.141	0.001	0.35
Z	0.046	0.000	0.19
CONSTANT	0.120	-	-

$R^2 = 0.701$

D.F = 22

SOURCE : FIELD DATA : 1989.

TABLE 8.14

REGRESSION RESULTS FOR THE USE OF TRACTORS FOR MAIZE SHELLI IN SABOTI DIVISION.

DEPEDENT VARIABLE : LN (T4) = TIME IN HOURS THE TRACTOR USED FOR SHELLING.

REGRESSOR	COEFFICIENT ESTIMATE	R^2 CHANGE	T-STATISTICS
P4	0.213	0.563	3.71*
X	0.861	0.119	2.0
D1	0.906	0.016	3.16*
M1	0.105	0.051	2.14
Y	0.224	0.025	2.04*
Q1	0.517	0.008	0.75
V1	-0.058	0.008	0.74
F	0.156	0.006	0.99
M4	0.029	0.005	0.66
M2	-0.015	0.002	0.50
CONSTANT	0.152	-	-

R^2 = 0.804

D.F = 22

SOURCE : FIELD DATA - 1989.

TABLE 8.15

REGRESSION RESULTS FOR THE USE OF TRACTORS FOR OTHER ACTIVITIES IN SABOTI DIVISION.

DEPENDENT VARIABLE : LN(T5) = TIME IN HOURS THE TRACTOR WAS USED FOR OTHER ACTIVITIES.

REGRESSOR	COEFFICIENT ESTIMATE	R^2 CHANGE	T-STATISTICS
P5	0.201	0.561	4.97*
N	0.456	0.106	2.89*
M14	-0.070	0.014	1.25
D1	0.226	0.007	0.95
M6	-0.448	0.009	0.70
D8	0.008	0.004	0.62
F	0.199	0.001	0.69
A	-0.379	0.004	0.59
CONSTANT	1.253	-	-

R^2 = 0.706

D.F =24

SOURCE: FIELD DATA : 1989.

TABLE 8.16

REGRESSION RESULTS FOR THE USE OF TRACTORS FOR SHELLING IN CHERANGANI AND KWANZA DIVISIONS **

DEPENDENT VARIABLE : LN(T4) = TIME IN HOURS THE TRACTOR WAS USED FOR SHELLING.

REGRESSOR	COEFFICIENT ESTIMATE	R^2 CHANGE	T-STAT
P4	0.219	0.729	6.36*
Q1	0.223	0.028	2.79*
Z	0.101	0.006	1.14
E	0.057	0.003	1.05
V1	0.007	0.001	0.28
CONSTANT	0.444	-	-

R^2 =0.768

D.F = 66

** MEANS THAT THE TWO DIVISIONS WERE TAKEN AS AREGION.
SOURCE : FIEID DATA 1989.

TABLE 8.17

REGRESSION RESULTS FOR THE USE OF TRACTORS FOR SHELLING IN KWANZA AND SABOTI DIVISIONS.

DEPENDENT VARIABLE :LN(T4) = TIME IN HOURS THE TRACTOR WAS USED FOR SHELLING.

REGRESSOR	COEFFICIENT ESTIMATE	R^2 CHANGE	T-STAT
P4	0.227	0.680	6.16*
Q1	0.151	0.021	1.47
F	0.209	0.015	1.67
Z	0.109	0.008	1.22
W	0.251	0.005	1.10
Y	0.066	0.003	1.0
A	0.038	0.002	0.55
V1	-0.10	0.001	0.2
CONSTANT	0.072	--	--

$R^2 = 0.735$

D.F = 59

SOURCE ;FIELD DATA ;1989.

CO

APPENDIX 3

CORRELATION COEFFICIENTS BETWEEN THE EXPLANATORY VARIABLES:

In this appendix, we present the correlation coefficient between explanatory variables which we thought could lead to a multicollinerity problem. One of the assumption of lines regression models is that "one of the independent variable should not be a linear combination of any of the remaining indepdent variables" and therefore the violation of this assumption may lead to the multicollinearity problem; whose results are:

(i) estimated standard errors will tend to be large implying lack of precision in the estimators. This might lead to wrong conclusions being made.

(ii) The estimates of the coefficients are in determinate.

In this study, the multicollinearity problem was identified by checking the correlation coefficient mafrix of the data set. A value of ± 0.600 was fixed as a cut off point and therefore any correlation coefficient between two explanatory variables with a value less or more than 0.600 led to the following:-

(a) We dropped one of the two variables involved.

(b) We left the variables if they were statistically significant: (change: P61

Shows that if the correlation coefficient between two explanatory variables is high and if one or both estimated coefficients of these variables are not significant, the presence of multicollinearity becomes a suspect. Otherwise the reverse happens:

In the table below we present some of the explanatory variables which had a high level of correlation.

Highly Correlated Explanatory Variables with their Correlation Coefficients

	M4	Q1	MS	M6	M7	X	M14
Q1	1.00	-	-	-	-	-	-
P4	-	0.701	0.819	-	-	-	-
D8	-	-	-	0.990	0.98	-	-
P1	-	-	-	-	-	-0.613	-
M16	-	-	-	-	-	-	0.700

note the cut off point is ±.600

- means that the correlation coefficient is small.

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