A STUDY

OF HOUSEHOLD ENERGY CONSUMPTION

AND SUPPLY PATTERN IN ASELLA TOWN

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Kebede Fufa

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Addis Ababa University
School of Graduate Studies

A STUDY OF HOUSEHOLD ENERGY CONSUMPTION AND SUPPLY PATTERN IN ASELLA TOWN

BY
KEBEDE FUFA

Approved by Board of Examiners:

Kailash Nath Singh (Dr) Kailash Nath Singh
Advisor

Mekonnen Kassa
Examiner

Tesfaye Shiferaw (Dr)
Examiner

ADDIS ABABA UNIVERSITY

THE SCHOOL OF GRADUATE STUDIES

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ABBREVIATIONS

BLT	-	Branches, Leaves and Twigs
C_{02}	-	Carbondioxide
Gcal / yr	-	Gega calory per year
HHS	-	Households
Kg	-	Kilogram
Kwh	-	Kilowtt hour
Kgoe	-	Kilogram of oil equivelent
LPG	-	Light petroleum and Gas
Mewb	-	Moisture content wet basis
MJ	-	Mega Jule
Mwh	-	Mega watt hour
N. da	-	No data
SHHS	-	Sample Households
TJ	-	Tera Jule
US $	-	United State Dollar

ACRONYMS

ACTI	-	Advisory Committee in Technological Innovation
EEA	-	Ethiopian Energy Authority
EEPCO	-	Ethiopian Electric Power Corporation
EESRC	-	Ethiopian Energy Study and Research Center
EFY	-	Ethiopian Fiscal Year
EIGS	-	Ethiopian Institute of Geological Survey
EMA	-	Ethiopian Mapping Authority
FAO	-	Food and Agricultural Organization
LDC'S	-	Less Developed Countries
RSOTW	-	Regional Survey of the World
TETH	-	The Ethiopian Herald
TWBE	-	The World Book Encyclopedia
TWRI	-	The World Resource Institute
UN	-	United Nation
UNDP	-	United Nation Development Program

ABSTRACT

The consumption pattern of household energy shows that multiple fuel use is common in sample households and both traditional biomass fuels (fuelwood, charcoal, BLT and saw-dust) and modern fuels (electricity and kerosene) are consumed for domestic purposes in Asella town.

Traditional fuels are important energy sources in terms of both expenditure and heat value i.e., they accounts 61.39% of the total expenditure and 86.32% of the total consumption in terms of heat value while modern fuels accounts 38.61% of the total expenditure and 13.68% of the total consumption.

The amount of monthly expenditure on different types of household energy varies depending upon the type of energy sources used which mainly determined by household income. Thus , total consumption of traditional fuels decreases with increasing household income while the consumption of modern fuels increase with increasing income.

The correlation between total expenditure on household energy and household size is +0.3156 while with household income it is +0.6010. It means it is the economic status of the households which determines the expenditure rather than household size.

The supply of biomass fuels on one market day and one non-market day indicates that fuelwood, charcoal, BLT, tree roots and dung were supplied by different means of transport: human labor (women's, men and children) and pack animals (donkeys and horses).

Acacia and erica arborea were the dominant tree species supplied for charcoal while eucalyptus, erica arborea, hagenia abyssincia and hypericum revolutun were supplied for fuelwood.

The distance-woodfuel supply relationship for the town indicates that charcoal and fuelwood were supplied from supply sources located at different distance. Thus, fuelwood and charcoal were supplied from distance located at a radius of 12.2 km and 19.7km respectively from the center of the town.

The supply of fuelwood and charcoal was a secondary occupation to supplement means of earning income for farmers, housewives, students and also for peoples without any permanent job.

Variation in the amount of woodfuel supply and price was found between summer season (June, July and August, 1999) and winter season (Dec., 1999,Jan., and Feb., 2000). Price of charcoal & fuelwood was lower in summer than in winter. Low price in summer season was due to food shortage and climatic condition (failure of rainfall during spring season of 1999). As a results rural people were forced to supply more than the need of urban consumers. High price in winter season was due to shortage of supply i.e., suppliers had other means of livelihood rather than the supply of woodfuel and they were also involved in harvesting activities.

Kebede Fufa

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CHAPTER ONE

INTRODUCTION

1.1 THE PROBLEM

The root cause of various types of environmental degradations are population pressure, urbanization and the adoption of environmentally unfriendly technologies that rely heavily on the extensive use of natural resources (Mekete, 1996: p. 218). In Ethiopia, ever increasing population pressure on land, among other things, is accelerating the pressure on woodfuel in the absence of substitutes and thus, is making fuelwood and charcoal scarce. Deforestation and woodfuel scarcity is being further aggravated by the rapid urbanization, which also contributes to the increasing commercialization of wood in urban centers.

In Ethiopia, there is a large section of the population that suffers from an acute scarcity of household energies, not only of modern forms, but also increasingly of traditional forms. Thus, UNDP/World Bank (1984: p.10) indicate that the shortage of woodfuel for household cooking is the most important energy problem facing Ethiopia.

Urban households unlike most rural households, usually purchase their fuelwood and charcoal. The increasing demand obviously results in rise of prices leading to increased economic burden on the consumers and hitting hard specially on the urban poor. This has become a perpetual feature in the country as a whole and in urban areas in particular. These days, the urban poor on an average, has to spend about

35% of their income on household energy only (EEA, 1992: p.14). This large share expenditure puts high economic strains on the budget (Denkeneh, 1984: p. 27) which results very often in the curtailment of their secondary and tertiary needs sometimes even their essential needs as well.

The town, Asella, is in no way exception to this pattern. The demand for fuelfood is increasing due to higher population growth of the town (natural as well as town ward migration) which is 3.7% each year based on the records of 1984 (32,954) and 1994 (47,391) the two reliable population and housing censuses.

Similarly, the price of fuelwood increased sharply from birr 22.26/m^3 in 1987 to birr 72.54/m^3 in 1998 (CSA, 1988, 1998) showing an increase of 225.9% over the price of 1987.

According to one recent study, regarding the problems associated with inputs of "katikala" production in the town, out of 200 sample "katikalla" producers interviewed, shortage of fuelwood was recorded as a first problem by 180 (91.0%) of the respondents (Tesfaye, 1999: p. 80).

In general, shortage of fuelwood and associated increases in price is attributed to prolonged deforestation resulting in decline in quantity at the source in the area surrounding Asella town which according to Terefe is affected by growth of population in the town:

> "Together with the growth of town's population the demand for forest products unquestionably increased fast. That is, because of increased demand for wood, particularly for construction of

houses, firewood, house or office furniture etc., . This greatly encouraged deforestation of the surrounding forest of Asella" (1992: p. 51).

Given the assessments of urbanization, deforestation, fuelwod scarcity and associated increases in price, it becomes imperative to assess the supply situation and consumption patterns of household energy. This will help for introduction of practicable conservation techniques and suitable substitutes of sources of energy so as to cope up with one of the most challenging household energy crisis and related environmental problems.

1.2 OBJECTIVES OF THE STUDY

In light of the problems stated above, the objectives of this study are the following:

1. To assess the supply situation and prices of the biomass fuels in general, (fuelwood and charcoal) in particular and non-biomass (electricity and kerosine) fuel,
2. To identify the specific type of tree species used for woodfuel (fuelwood and charcoal).
3. To investigate the distance and source of supply of woodfuel for Asella town.
4. To determine the amount of energy inflow from charcoal and fuelwood interms of heat value
5. To examine the patterns of household energy consumption by types and quantity (based on the expenditure and heat value).

6. To investigate the relationship between energy consumption and income as well as household size,

In other way, the study will try to answer the following research questions:

a. From where and how far biomass fuel is supplied to the town? By what means of transport and who are the suppliers?
b. What are the types of biomass supplied, their proportions and at what price?
c. What are the tree species used for woodfuel?
d. What is the overall monthly/annual per capita biomass and non-biomass energy consumption?
e. What relationship exists between family income and corresponding expenditure on consumption of various sources of energies and how are they related with household size? What relationship exists between family size and expenditure?

1.3 HYPOTHESIS

The conceptual analysis of this paper is framed around the following working hypothesis:

1. Charcoal suppliers come over longer distance than fuelwood suppliers.
2. There is seasonal variation (between summer and winter) in price as well as the supply of fuelwood and charcoal.

3. The most important household energy in the study area is woodfuel (fuelwood and charcoal).
4. Consumption of modern fuels (electricity and kerosene) increases with increase in family income resulting in decline in consumption of woodfuel.
5. Electricity is mainly used for lighting and the number of electrical appliances used by the family increases with rise in income.
6. Percent expenditure on household energy decreases with increasing income.
7. There is direct relationship between family size and total expenditure on household energy.

1.4 SIGNIFICANCE OF THE STUDY

Energy used for household purposes is like the basic needs (food, clothing and shelter) whose provision requires intensive study and careful planning. It is therefore, essential to undertake a survey on household energy consumption pattern at different levels. Thus, the presence of such a micro level inquiry would enable:

1. To consider alternative energy production and consumption techniques inorder to cope with woodfuel crisis;
2. To establish demand and supply pattern and household energy management even for future,
3. To ameliorate environmental degradation and energy related environmental problems,
4. To provide information for planners and policy makers in the formulation of energies policy in general, and household energies in particular.

5. To serve as a guide for future studies.

1.5 LIMITATIONS

The main limitations of this study are two. The first was, it lacks to evaluate the role of free collection in household energy consumption. Thus, the analysis of household energy consumption was based on expenditure made on it which can also be converted into heat value. However, low quality traditional biomass fuels such as: BLT, dung and to some extent three roots are obtained through free collection by consumed by some of sample households.

The second limitation was due to shortage of time it fall to include the types of appliances used for household energy utilization.

1.6 ORGANIZATION OF THE PAPER

This paper consists of seven chapters. The first chapter deals with an introductory part which consists of the problem, objectives, hypothesis, significance and limitations of the study.

The second chapter deals with the review of the literature in which research results on types of energy sources and household energy consumption and utilization were discussed.

The third chapter deals with methods and procedures used in data collection and analysis.

Chapter four analyze consumption and expenditure pattern of household energy. At the beginning part of this chapter expenditure on household energy by income and fuel types is examined. And then followed by analysis of the relationship between dependent variable (expenditure on various household energy) and independent variables (household size and household income). This followed by discussion of household energy consumption. And at the end of this chapter per capita consumption of woodfuel, electricity and kerosene would discussed.

Chapter five deals with the supply of biomass fuels and the characteristics of the suppliers. Thus, it includes biomass fuel supply situation along with means of transport, energy inflow from supplied fuelwood and charcoal, characteristics of charcoal & fuelwood suppliers, source of woodfule supply, types of three species supplied as woodfuel, distance - oodfuel supply relationship, duration of involvement in supply activity, frequency of supply and seasonal price of woodfulel.

Finally, in chapter six, general conclusions and recommendations would be given.

CHAPTER TWO

REVIEW OF THE LITERATURE

2.1. TYPES OF ENERGY SOURCES

Energy manifest itself in many forms, and it is used in many ways to sustain life. Cook (1976:P.17) divides the sources of energy into two categories of renewable and non-renewable. Renewable energy sources are those of steady direct supply or those that represent readily replenishable reservoirs. Non-renewable resources are those that represent energy traps or reservoirs not replenishable on any particular human time scale.

Similarly, Chapman (1989:pp.3-4) also groups primary energy sources into renewable and non-renewable classes. According to him, the concept of renewabelity is based on the time taken to replace the supply in relation to the time scale of human events. Non-renewable energy sources are those which can not be replenished with in the span of human time.

Sheehan (1982:p.73) further classifies renewable energy sources under three broad categories:

I. biomass in its traditional solid forms (wood and agricultural residues);
II. biomass in non-traditional forms (converted into liquid and gaseous fuels) and,
III. solar, wind and mini hydro installation.

Ahuja, D.R. (1990:p.125) highlight that biomass in one form or another continuous to be the predominant source of energy for at least half of the world's population. In many countries such as Nepal, Ethiopia and Guatemala over 90% of total energy used comes from biomass.

Biomass as renewable energy source covers diverse materials. Thus, UN (1987:p.10) divides biomass resources into:

- Woody biomass (forest/wood land and plantain resources, ago-industrial plantain resources and on form tree resources),
- Non-woody biomass (agricultural crop resources, crop residue resource and processing residue resources).
- Animal waste which refers to wastes from intensive and extensive animal husbandry

Shewangizaw (1996:p.11) points out the importance of biomass as follows:

> *"Biomass is an attractive energy source because of diversity of renewable resources available, and the flexibility and range of its use-ages. In addition, the conversion processes produce a wide range of fuels with by-products which can be used as food, fertilizers and chemicals."*

Oelert, G.et.al. (1985:p.4) and CESEN (1986:p.2) classify energy as being made up of two groups of sources. The first is modern (commercial or conventional) energy which is commercially or rather monetarily traded like petroleum, natural –gas, coal and primary electricity.

The second group is traditional (non-commercial or non-conventional) energy, which mainly includes, wood, plant and animal waste, as well as animal traction and human muscle power.

Bhatin (1984:p.384) further sub-divides the non-conventional sources of energy into two broad categories:

The first being animate energy sources which include animal draft power and human power which are important source of energy in developing countries, like Ethiopia, providing up to 90 percent of all energy used in traditional agriculture systems.

The second category includes biomass and related sources, such as: woodfuels, firewood, shrubs, charcoal, sawdust, crop residues (straw, rice husk, bagasse, jute, cotton and tobacco sticks) and animal residues (dung cakes and biogas).

Hosier (1985:p.9) notes traditional fuels as fuels that have been used for centuries and usually freely gathered. According to him woodfuel, dung, crop residues, sisal and similar substance are the most significant fuels in this category. He further indicates that woodfuels, (which include firewood and charcoal) are the most significant traditional fuels. And crop residues and dung have become more important with increasing scarcity of wood. Thus, traditional fuels fulfill a large share of domestic energy needs in developing countries.

Similarly, the energy sources used in Ethiopia can be classified into traditional and modern. According to EMA (1988:p.53) traditional forms of energy sources are firewood, charcoal, farm residues, dung and animal and human power. And modern forms of energy sources include hydroelectricity, fossil fuels, geothermal energy (power), coal, biogas, solar power and wind.

2.2. HOUSEHOLD ENERGY CONSUMPTION, ENERGY CRICICS AND POPULATION

EEA (1991:p.3) defined household energy consumption as:

> *"energy used for non-commercial domestic and closely related activities; such consumption is neither for providing services nor for generating income. However, most energy intensive household activities are cooking, fuel collection, water collection, lighting and ironing."*

Furthermore, according to Amman and Wilson (quoted by Chapman, 1989:p.27) consumption of energy in domestic sector refers to that consumed at household level, both within the residence and beyond it.

In the developing world, wood is an energy source that is already familiar to the majority of the population (Cocklin, C.et.al. 1986: p.371). And energy in rural areas of Africa means fuelwood where wood and its by-product charcoal account for 90 and 98 percent of total household energy consumption (FAO, N.da: p.35). In countries such as Mali, the Upper Volta (Burkina Faso) and Ethiopia fuelwood's share in national energy consumption is estimated to exceed 90 percent. And in the continent as a whole, 9 out of 10 people depend on fuelwood for much of their household energy (ibid.).

Throughout Africa, reports estimated, that wood demand would outrun sustainable supplies either currently or in immediate future.. Eckholm (1980:p.65) notes that fuelwood is reported to be a scarce and expensive item throughout the sub-Saharan fringes of Africa, all the way from Senegal to Ethiopia. Hosier, R.H. et.al. (1980:p.144) cite deferent studies, which indicates that Kenya, Malawi, Sudan, Somalia, Mauritania, Nigeria, Ethiopia and Zimbabwe were all facing severe woodfuel shortages.

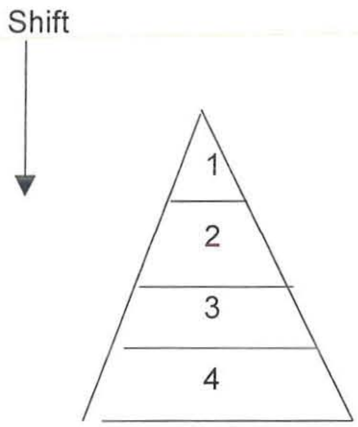
Salih (1993:p.1) highlight evidences suggesting that environmental degradation in Africa is faster than the region's economic decline. More seriously, trees in sub-Saharan Africa are being felled 30 times as fast as they are being replaced, showing the highest rate of deforestation in the world. Thus, the rate at which woodfuel resources are depleted outstrips the rate at which they are replenished, especially through replanting by 29 to 1; and making forests the fastest depleted resource on the continent.

Kaale, B.K. (1990:p.60) indicate deforestation is rapid in East Africa, the main causes begin clearing of land of agriculture and livestock; cutting of trees for fuel; uncontrolled wild fire and clearing of forests for settlement. In his study, "Population and Household Energy in Ethiopia," Mengistu (1991:p.218) points out the worsening situation of deforestation as follows:

> *"As a result of massive deforestation most developing countries including Ethiopia have now found themselves in the last phase where fuelwood the mainstay of the household energy, has become scarce, transition to lower quality biomass fuels (agri-residues, dung and leaves) has occurred woodfuel prices are on the rise."*

According to Kaale, B.K. (1990:p.60) the main indicators of scarcity are the gathering of green instead of dry wood, spending more time to collect fuelwood, supplementing fuelwood with other biomass like farm residues and animal dung, starting the use of tree species not preferred as sources of fuelwood before, recognition of fuelwood as marketable item, the increasing price of charcoal, consumers' minimization of fuel consumption, some times by cooking one meal for lunch and dinner instead of cooking two meals. .

In general, because of deforestation and associated scarcity, Mengistu (1991:p.218) portrayed the direction of shift from woody biomass (top quality fuelwood) to general and low calorific value biomass (twigs, leaves, agri-residues, animal dung, etc.,) as shown in the following figure.



1. Top quality fuelwood
2. Lower quality fuelwood
3. Branches, Leaves, Twigs, etc.,
4. General biomass

Fig.1. Biomass Fuel Availability and the Direction of Shift in Use

Source: Mengistu Teferra, Population and Household Energy in Ethiopia, 1991:p.219.

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Chapman (1989:p.25) points out that the energy consumed by a society is a function of number of people times their wants and their ability to satisfy them which may very much depend on income, settlement pattern, life style of the people, etc.

People in many of the developing countries are facing the severe wood shortage which is likely to be doubled in the next 25 years, putting unbearable, pressure on the remaining wood land (ACTI, 1980:p.6). The ever increasing demand of woodfuel, either for firewood or charcoal, due to population increase, implies not only deforestation but also resulted in dung and crop residues to be used as an alternative or substitute for cooking with serious implications for agricultural adverse impact on soil fertility (UN/World Bank, 1984:p.4). .

Abakah, E.M. (1990:pp.227-228) indicates that the over dependence on woodfuel could be ascribed to factors such as: increasing population, increasing pressure on forest and grassland, low efficiencies of devices used, poor conservation methods, and inherent traditional practices of the people.

Energy supply is the total quantity of usable energy available to people for doing work. Different forms of energy are used to operate machinery; to heat and cool homes and offices, to cook, to provide light, and to transport people and goods (TWBE; 1994:p.277). In Ethiopia, household sector account for an over-whelming of the consumption, concerning the share of sectoral consumption and energy supply Yemane(1985:p.3) noted that household sector is the major consumer of energy, accounting for more than 85% of the total national energy supply.

Accordingly, the final energy consumption in 1988 EFY indicates that, out of 722,869 TJ energy consumed in Ethiopia, household, industrial, service and others, transport and agricultural sectors consumed 89.2%, 4.6%, 3.6%, 2.5% and 0.1% respectively (see Table 1).

Table 1. Final Energy Consumption by Sectors and Fuel Types, in Tera Jules (TJ) 1988 EFY

SECTORS	FUEL TYPES						TOTAL	
	Biomass Fuels		Petroleum Products		Electricity			
	TJ	%	TJ	%	TJ	%	TJ	%
Households	635,694	93.0	7,034	20.0	2,020	43.9	644,748	89.2
Agriculture	-	-	816	2.3	-	-	8,16	0.1
Transport	-	-	17,918	51.4	-	-	17,918	2.5
Industry	24,052	3.5	7,292	20.9	1,976	42.9	33,320	4.6
Service & Others	23,653	3.5	1,804	5.2	6,10	13.2	26,067	3.6
Total	683,398	100	34,865	100	4,606	100	722,869	100
Percent	94.54%		4.82%		0.64%		100%	

Source: *Mekonnen Kassa, Updated National Energy Balance for 1986-1988 EFY, Final Draft, Unpublished, June 1997, p.10*

As far as per capita household energy consumption is concerned, the study made by UNDP/World Bank (1984:p.4) found that:

> *"Household energy consumption in cooking is believed to average about 2kg. of air-dried wood (25% mcwb) per person per day, however; consumption levels vary greatly depending on local supply constraints. Per capita consumption of modern energy forms (petroleum and electricity) is now about 25 kgoe, which makes Ethiopia the least energy intensive countries in the world."*

CESEN (1986:p.3) also provides per capita household energy consumption in Ethiopia as follows:

> *"considering a total of 42 million inhabitants, per capita energy consumption in household sector amounted to 2.69 Gcal/yr. or about 2.1 kg of fuelwood equivalent per day.*

In Ethiopia, it is widely accepted that the most important sources of household energy are traditional biomass fuels and this pattern is expected to change only very slowly in coming decades (Fekerte, 1991: p.3.). RSOTW (1993:p.343) also indicate that:

> *"Ethiopia is very low consumer of energy, with the largest source being wood, charcoal and animal and agricultural waste."*

The amount and form of energy consumed by all sectors in general, by household sector in particular, indicates the level of economic and social development attained by different countries.

Table 2. Household Energy Consumption by Fuel Type, 1988 EFY (1995/96 G.C.). In Tere Joules (TJ).

Fuel	Urban Households		Rural Households		Total	%
	TJ	%	TJ	%		
Fuelwood	23,576.90	4.56	493,341.70	95.44	516,918.60	80.17
Crop Residues	2,872.59	5.43	50,038.49	94.57	52,911.08	8.21
Dung	3,589.85	6.05	55,701.68	93.95	59,291.53	9.20
Biogas	0.23	20.35	0.90	79.65	1.13	-
Charcoal	3,969.55	60.40	2,602.30	39.60	6,571.85	1.02
Biomass Total	34,009.12	5.35	601,685.07	94.65	635,694.19	98.60
Kerosene	6,250.31	95.24	312.06	4.75	6,562.37	1.02
LPG	161.68	100.00	-	-	161.68	0.02
Diesel	119.14	38.89	187.23	61.11	306.37	0.05
Electricity	2,020.44	100.00	-	-	2,020.44	0.31
Modem Total	8,551.57	94.48	499.29	5.52	9,050.86	1.40
Grand Total	42,561.19	6.60	602,184.36	93.4	644,745.05	100

Source: *Mekonnen Kassa, Updated National Energy Balance for 1986-1988 EFY, Final Draft, Unpublished, June 1997, p 62.*

As it can be seen from Table 2, in 1988 EFY the consumption of biomass and modern fuels by the households in Ethiopia accounted for 98.6% and 1.4% respectively. Table 2, also indicates the household energy consumption was estimated at 644,746

TJ in 1988 EFY out of which rural and urban households consumed 93.4 percent and 6.6 percent respectively. Although the respective shares in population are 86.8% and 13.2% (in 1994 G: C.), the low level of energy consumption by urban households may be attributed, partly to,

The patterns of energy consumption differ significantly between urban and rural areas as is evident from the data of 1988 EFY (Table 3). The use of traditional biomass fuels by urban households accounts for 79.9 percent (55.4 percent fuelwood, 9.3 percent charcoal, 8.4. percent dung and 6.8 percent crop residues) while modern fuels accounts for 20.38 percent (15.35% kerosene & LPG, 0.28% diesel, 4.75% electricity) of the total urban household consumption.

Table 3. Composition of Fuel Use in Urban and Rural Households, 1988 EFY.

Fuel	Percent of Total Consumption	
	Urban	Rural
Fuelwood	55.40	81.93
Crop Residue	6.75	8.31
Dung	8.43	9.25
Charcoal	9.33	0.43
Biomass Total	79.90	99.02
Kerosene	14.69	0.05
LPG	0.38	-
Diesel	0.28	0.03
Electricity	4.75	-
Modern Total	20.10	0.08

Source: *Mekonnen Kassa, Updated National Energy Balance for 1986-1988 EFY, Final Draft, Unpublished, June 1997, p 63.*

In rural areas household energy consumption was dominated by traditional biomass fuels (99.92%) which has a break up of 81.93%, 9.25%, 8.31% and 0.43% respective to fuelwood, dung, crop residues and charcoal. The share of modern fuels (which is mainly kerosene & diesel) is very poor i.e., 0.08 percent of the total rural household energy consumption.

As in most of the developing countries, woodfuel accounts the largest share of household energy consumption in Ethiopia. The continued dependence on woodfuel as the country's major energy source in both rural and urban areas has resulted in the devastation of the natural bio-system at a faster rate and leading to ecological imbalance (EIGS, 1991:p.1.). According to EESRC (N.D.: p.2.) the current state of forest in Ethiopia (below 3%) implies that the situation is getting worse and worse.

The utilization of forest resource in general, and the use of woodfuel (firewood and charcoal) for household energy in particular, is linked to environmental degradation in the form of deforestation. Thus, as a result of rapid population growth and lack of due attention to the protection of natural resources, about 65 percent of Ethiopia's total area is reported to have become vulnerable to ecological degradations, resulting in environmental changes and desertification at present (TETH, 1999). Consequently, the country has been facing woodfuel energy crisis of immense magnitudes due to shortage of fuelwood which indirectly affects agricultural resources on which much of the country's economic activities depend.

The following model called "Model of Desertification" by Musgrove (adopted by Tamiru, 1997) is apt enough to depict the effect of rapid population growth.

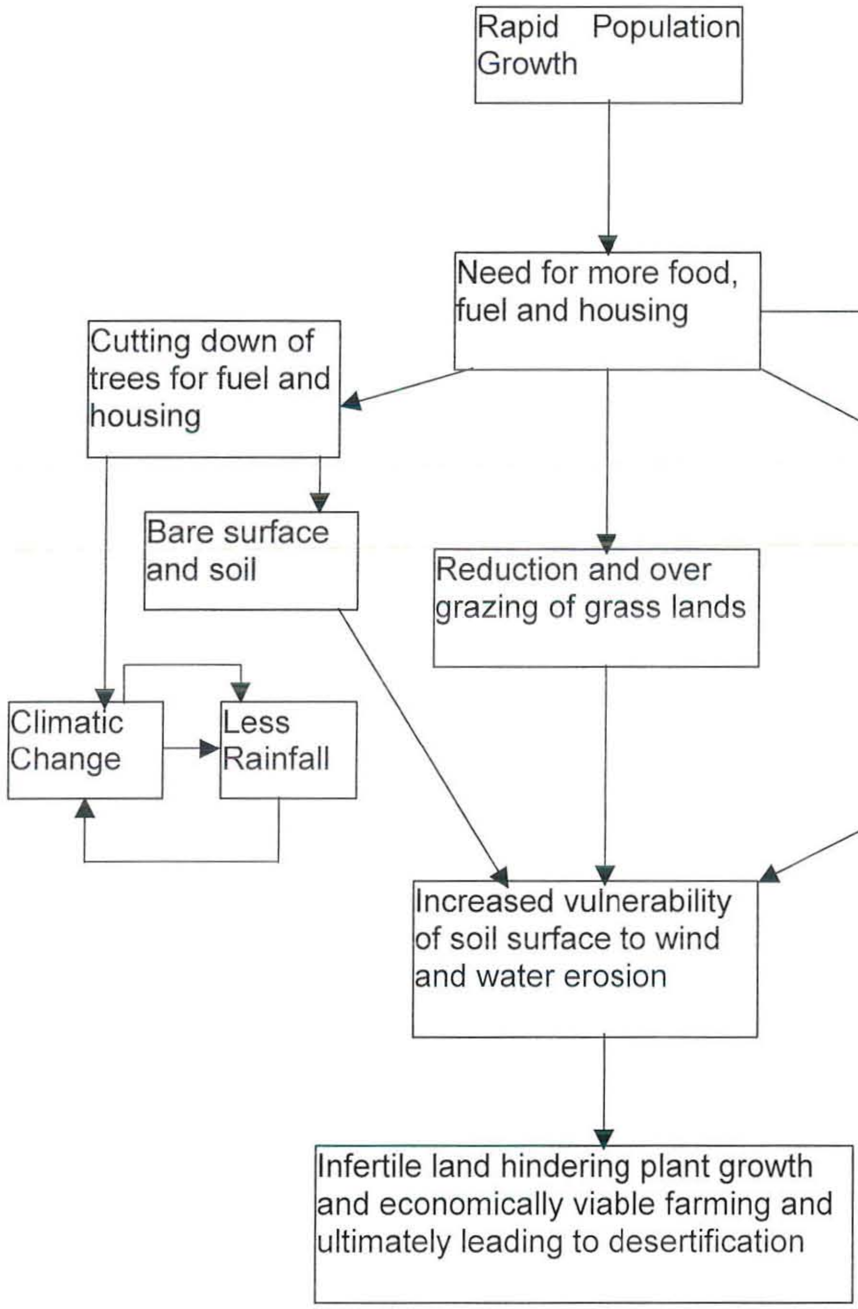

Fig 2: Model of desertification

Source: Adopted from Tamiru Geleta, Population and Environment. A paper presented in workshop on "Population and Family Life Education" organized by Oromiya Education Bureau, Bishoftu, April, 1997, p.23

2.3. FACTORS AFFECTING HOUSEHOLD ENERGY COSUMPTIN

There are a large number of variables, which affect household energy consumption pattern. Beaumont and Keys (1982:pp.67-68) grouped them into two; the first includes the type of house, the activity pattern of the household members and the household income which can be regarded as factors having direct impact on energy demand of a particular household while the second pertains to the spatial location in an urban area, and the occupation of the head of the household, their social status, etc., which may have an effect on the level of energy consumption indirectly and yet need to be examined.

According to Barnes, C.et.al (1984:p.1) a country's demand for household energy is linked with factors such as size of population, degree of urbanization and industrialization, dietary patterns and levels of technological development. And effective demand, however, is related to economic conditions, which influence the availability i.e., supply, and competitiveness of demands in relation with the supply and access to source of energy.

Considering urbanization and the supply of electricity Pachauri (1990:p.321) indicates that the largest section of the population in developing countries still live in rural areas where access to electricity is very limited. According to him access to electricity is more or less associated with income increase. That is, electricity grids and distribution lines are extended to area where the potential demand for electricity already exists. This demand is generated by increases in income.

In his study "Energy Use in Rural Kenya", Hosier (1985:pp.23-27) observed that availability of fuel, its substitutability, income, climatic patterns and household composition (size) all appear to play a role in determining rural household energy use. CESEN (1986:P.6) further emphasis that the level and pattern of energy consumption will generally be strongly influenced by local availability of the natural resources. Thus, demand or consumption of different fuels is, in part, a function of supply also.

Maikhuri, R.K. and Gangwar, A.K. (1991:pp.164-165) in their study "Fuelwood use by Different Tribal and Non-Tribal Communities in North-East India," they also explored that apart from resource availability, other factors such as climate, season of the year, family size, type of food cooked and method of cooking influence per capita fuelwood consumption. Particularly they highlighted that the size of the families have significant influence on per capita consumption i.e. the large families consume lesser fuelwood per capita as compared to the small and medium size families.

According to Chapman (1989:p.5) the selection of types or a mix of energy sources to meet the demand of different societies vary in response to a number of factors. Such mixes change with time and vary from place to place. The list of these factors is as follows:

i) Occurrence and Accessibility and exploitability:- Many energy sources are confined to specific environments and their remote (inaccessible) location limit the supplies. Availability is subject to prevailing transport systems. Even physically present sources may not actually exploited due to technical, economic or other constraints.

ii) Transferability - The distance over which an energy source may be transported is a function of its physical form, energy content and transport technology.

iii) Thermal Efficiency (Energy content):- It refers to the proportion of effective energy as per calorific value, weight or volume of a given source. Energy sources with low calorific value, brought from farther distances prove to be inadequate when demand is larger. Thus, charcoal is often favored over fuelwood as an urban fuel because it has a higher energy content (calorific value) per unit weight and therefore cheaper to transport (Kaale, B.K. 1990:pp.18-19).

iv) Reliability of Continuos Supply:- Uninterrupted availability gives a source an advantage over the other whose supply and availability is intermittent.

v) Storability - To meet interruptions of supply or peaks of demand, a source which can be stored has an advantage over one which can not be stored.

vi) Flexibility of Use:- The greater the variety of end uses to which a given source or form may be put, the more desirable it is.

vii) Safety of use, Environment and Impact:- Sources which may be produced or used with low risks to human health and the environment will be preferred over less benign sources. Concerning environmental impact, the inefficiency of the fuelwood utilization can exacerbate deforestation with all its potential deleterious consequences: soil erosion, deforestation, sedimentation, flooding and contribution to net atmospheric carbondioxide releases (Ahuja, D.R. 1990:p.126).

viii) Cleanliness, Convenience and pollution Effect:-The cleaner and more convenient sources will be preferred over the dirty (indoor air pollutant) and cumbersome ones. Cooking oven in developing countries are routinely exposed to very high levels of indoor air pollution. Ahuja, D.R. (1990:p.129) highlighted that from an environmental prospective, cook ovens using fuelwood, charcoal, dung and crop residues beside being fuel-efficient, must also have low emissions of green house gases and pollutants. Anderson, D. (1996:P.11) further suggests that indoor air pollution could be almost entirely eliminated by substituting cleaner and convenient fuels (LPG, kerosene, or electricity) for fuels now used (fuelwood, dung, agri-residues etc.) in cooking in most developing countries.

ix) Price:- Low priced sources or form are preferred over high price one. Smith, K.R. (quoted by Ahuja, D.R. 1990:pp. 125-126) indicates that prior to the first oil crisis in 1973, economic development was accompanied by the substitution of sources with higher calorific value like kerosene and liquefied petroleum gas (LPG) for traditional biomass fuels. The increase in oil prices, however, made more difficulty to shift to these fuels for a substantial portion of the world's population and in fact in places there has been a return to traditional bimass fuels.

Soussan, J.et.al (1990.p.573) pointed out that patterns of domestic energy consumption's in urban areas are far more complex and dynamic than what they are in probable cause of rural areas in the following reasons:

1. Multiple fuel use is common in individual households. It is not unusual to find households using two, three or more type of fuels for the same purposes,

2. The structure of use of energy is different for different types of households. The main determinant here is economic status, but household size and location within the city are also important, and
3. Patterns of urban energy consumption are very dynamic (changing over time) as fuel prices, incomes and the availability of different fuels vary from time to time.

The individuals demands' for energy (or the intensity of use of the fixed capital stock) is determined by the price of fuel used, the price of other alternative or competing fuels, income and other characteristics of the residents and climatic variables (Lakshmanan, 1983: p.307). The variation in the price of fuel overtime depends on a multitude of factors (CESEN, 1986: p.27). Some of the factors are:

- Supply status at local level with respect to local energy requirements,
- Variation in the production and distribution costs of the existing energy sources,
- Competitiveness of prices in relation with other substitute fuels, and
- Social characteristics and income level of the users.

The competitive prices of the fuels can be used to examine the patterns of household energy consumption because they have an effect on the consumption. As a particular fuel becomes cheaper in relation to its substitutes, it is easier for it to compete against its substitutes for household's income (Beaumont and Keys, 1982:p.25). Where fuelwood supplies are plentiful, prices are lower and relatively unproblematic, but as cities grow and the resources of the surrounding regions deplete, prices rise to levels

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As far as substitutability (alternatives and direction of shift) is concerned, with increasing scarcity of fuelwood the alternative substituting fuels can be used and consumed by households (Hosier, 1985:p.25). These alternatives may be traditional (lower quality biomass fuels) or modern (better quality commercial fuels) in nature, depending up on the nature of the households involved. Thus, he says, under certain conditions the move (Shift) is likely to be towards a less sophisticated technology-fuel combination, under different conditions it is likely to be a more sophisticated alternative.

Abakah (1990:pp.230-231) indicates that households must have reasonably good incomes to invest in improved energy saving or energy efficient technologies. He deduced that:

> *"...with increased incomes and better standard of living most of the low-income urban dwellers (a major consumers of woodfuels) will shift to more 'decent' sources of fuel supply like LPG, biogas, kerosene, etc.--- but without an improvement in their standard of living and real incomes, the populace will opt for woodfuel."*

A steady transition to cleaner fuels occurs as income rises and as industries expand. By the time per capita annual income in a given country has risen to around US$ 1,500 the shift from traditional to modern fuels is almost complete (Anderson, D. 1996:p.11). Therefore; the budget or income constraint of a household is an important determinant of its overall pattern of energy consumption and expenditure (Beaumont and Keys, 1982: p.29).

It appears that important correlation does exist between household income and size, and the demand for energy. Other thing being equal, higher income generally leads to higher absolute levels of energy consumption and increasing use of expensive fuels. Increasing household size also leads to increasing consumption, but economics of scale ensure diminishing effects with each subsequent increase in size (CESEN, 1986:p.8).

Denkeneh (1984:p. IV) also indicated that the amount of energy consumed by the family increases with a rise in family income, but the quality of the type of energy used and the efficiency of domestic appliances employed are determined by the financial position of a family. Mengistu (1991:p.217) pointed out the common features of developing societies that dictate dependence on traditional energy sources in meeting subsistence (day to day) household energy needs as

I. Underdeveloped infrastructure for the supply of modern energy sources,

II. Financial burden of maintaining a sustained supply of modern fuels for all sectors, and

III. Prohibitive price of the modern forms of energy and the appliances that go with them.

Hosier (1985: p.15) also indicated that the major obstacle to the utilization of non-woodfuel energy source is the cost of the required stoves and appliances. As for example in Upper Volta (now Burkina Faso), a three stone open hearth type of domestic oven for burning fuelwood would costs nothing, while a butane stove and bottle can cost more than US$ 50.00. Charcoal oven can cost US$1-4, and paraffin stoves US$ 10-14. For many households, therefore, the costs of appliances may be prohibitive.

In his study, "Woodfuels: The Past and the Future for East African Energy" Kaale, B.K. (1990: p.69) noted that the choice of electrical energy is not a feasible alternative to wood for domestic cooking in Africa at present. He narrated that in 1984 a single burner electrical stoves were costing about US $ 300 in Tanzania where the average person had an annual income of about US$ 290. Even the imported stoves were not readily available for the few who could afford them. Therefore; according to Pachauri, R.K. (1990: p.321) electricity consumption pre-supposes a minimum standard in the structure of dwellings and ability to invest in wiring and other per requisites for use of electricity.

Climatic factors also create seasonal variation in the energy consumption patterns of the households. Tsegaye (1989:p.53) in his study, "Problem of Traditional Energy Supply in Two Villages of Northern Ethiopia", identified that during the rainy months of June July and August, households were faced with actual fuel shortages. The need for heating, the difficulty of using dung due to humidity and the existing wood shortages were factors for this seasonal variation of fuel consumption. He also pointed out that the households try to collect and store wood and dung during dry season to use them latter in wet season.

Hosier also highlights the influence of climatic factors on demand and supply of all fuels in general, and traditional fuels in particular, in the following words:

> *"On the demand side, temperature variations make it necessary for households to utilize different amount of*

fuel for space heating. ---on the supply side, insofar as rainfall determines biomass production rates, it directly influences the consumption of traditional fuels. If other factors are held constant (particularly population density), high rainfall areas can provide a greater sustainable wood offtake can therefore support higher wood consumption level." (Hosier, 1985:p.26).

Besides, the way in which a given population is distributed on the land has a lot to do with the pattern and level of energy consumption. Thus, a very different pattern of energy consumption, both interms of end-use and fuel types can be found in small urban settlement of say 20,000 inhabitants and large towns of say 150,000 inhabitants. This is so because urbanization and concentration of population usually result in a gradual exhaustion of natural energy sources in the immediate surroundings (CESEN, 1986:p.7).

2.4. HOUSEHOLD ENERGY UTILIZATION EFFICIENCY AND CONSERVATION

he major demand for energy in developing countries emanates from households for cooking, lighting and space heating (Barnes, C.et.al., 1984: p.1). Households utilize fuels and appliances in the home in various ways for different residential services e.g.: cooking, cleaning, cooling, heating, lighting, etc. (Lakshmanana, 1983:p.307).

Chapman (1989:p.27) puts some elements of major energy using functions common in households as "food processing (cooking, preserving), space conditioning (heating, cooling and lighting), cleaning and maintenance (personal built space, grounds), recreation and communications." The variations in the consumption patterns of households are "the results of different cultural characteristics and life style, income, available energy supply, and in the case of space conditioning, the prevailing temperature regime."

The methods that are applied in utilization of biomass fuels by most African households are actually both extremely inefficient and unhealthy. The most commonly used heating method is an open wood fire on the floor. With respect to fuel consumption it is wasteful, because the rate of burring can not be controlled in more than a rudimentary way, and it fills the room (kitchen) with smoke which are harmful to lungs and eyes (Poulsen, 1978:p.18).

Hayes (1981:pp.15-16) narrates the same thing saying that "in developing countries, the method of burning firewood is the crudest form of energy conversion, partly because many of the energy-rich gases and chemicals in the fuel are not converted into heat, and partly because of the heat that is produced tend to be wasted (vented to the atmosphere)."

In Ethiopia, the major use of traditional fuels is for cooking, which is done in traditional way that result in high fuel consumption and production of smoke. Thus, both in urban and rural areas, many of the traditional cooking ovens and open fire places that utilize biomass energy sources are used inefficiently as they focus the flame poorly on the cooking surface. Therefore; given the finite natural energy resources, it becomes important to device energy conservation methods.

Hauser (1982:p.96) defined conservation of energy as follows:

> *"Conservation of energy generally is defined as making more efficient use of energy in a process or work application."*

Beaumont and Keys (1982:p.11) point out that energy conservation (to reduce the rate of consumption) in general result from decreased demand or technological improvements to increase the efficiency of energy sources. ACTI (1981:p.64) also suggests that in developing countries like Ethiopia, with increasing demand for household fuel, because of population growth, and decreasing supplies because of depletion of energy sources, different conservation methods should be used. These include more efficient use of traditional fuels, better management of natural resources and wide spread substitution of alternative fuels.

Regarding the problem of fuelwood shortage and cooking stoves in LCD's. Wolde-Gihiogis (1984:pp.85-87) emphasizes that the improved stoves (i.e., firewood and charcoal oven) could significantly improve the efficiencies of household energy utilization, and thereby resulting in significant saving of woodfuel. But the fundamental problem in fuelwood shortage is not the use of inefficient stoves, but depletion of forest resources.

Poulsen (1978:p.19) also suggests that the fuel situation may not be improved by better management of existing forest resources and the planting of more trees, rather by reducing fuel requirements with the introduction of more efficient cooking stoves. Therefore; in the dissemination of cooking stoves, for household energy utilization, a number of factors should have to be considered.

The cost and expected life span of cooking stove are important criteria for consumers (Ahuja, D.R. 1990:p.130). Regarding the linkage between utilization of efficient energy devices and the level of income of the users, Abakah, E.M. (1990:p.231) concludes that:

> *"effort to introduce and popularize the utilization of efficient energy devices could be greatly facilitated by appropriate increase in real incomes, an improvement in the living conditions of the populace and adequate inflation control measures."*

As far as the improving of technologies and design considerations of bio-fuel burning ovens are concerned, Ahuja, D.R. (1990:p.130) highlights that the earliest concern of cook stoves was merely the exhaustion of the smoke from the cooking area; this was followed by concern to reduce fuelwood consumption and deforestation. To these must be added the need to reduce the emission of green house gases and other pollutants.

Dutt and Ravindreanath (1993:pp.653-656) in their study, "Bio-energy: Direct Application in Cooking", also indicated that cooking system must satisfy multiple criteria. At household level it must operate relatively faster and produce minimal smoke. In addition, the initial and operating costs of the system must be relatively low and the fuel supply should be reliable and affordable. In general, according to them, the criterions to be considered are fuel availability, stove suitability, fuel consumption, smoke and air pollution, economic and souci cultural factors.

Denkeneh (1984:p.iii) mentioned that what matters important to the consumers is not the gross energy consumed but the amount of services in the form of effective energy a family gets. He further emphasizes that the efficiency level of energy resource utilization determines the amount of useful energy received by a family for a given gross energy input. But according to ACTI (1980:pp.164-165) many factors, other than efficiency, complicate the acceptability of cooking stoves as is clear from the statement that:

> *"Cost, availability of materials, size and type of wood available, family size, cooking practices, and types of dishes to be produced. These vary greatly from region to region, which means that any given stove design may not be accepted or used efficiently outside the area where it was designed."*

More efficient utilization of energy, through different methods, can bring political, economic and environmental benefits as well as reduced reliance on energy imports and lower emission of carbondioxide and other pollutants (TWRI, 1988:p.5). Energy production and use are vital to the economies and environments of all countries. Beside, utilizing the mix of energy sources has profound consequences for environmental quality (TWRI, 1992:p.143). Therefore; for most developing countries, like Ethiopian, any single technological fix is not advisable, rather a mix of complementary energy supply must be sought (Hayes, 1981:p.15).

CHAPTER THREE

METHODS AND PROCEDURES OF DATA COLLECTION AND ANALYSIS

3.1 SOURCES OF DATA

The sources of data for this study are secondary as well as primary. The secondary data from sources such as official statistics from published and unpublished reports of government and non-government organizations, books and maps are used. Primary data is generated by administering questionnaire to obtain informations on biomass energy supply and household energy consumption.

3.1.1 Data for Biomass Energies Supply

To determine the type of tree species used for fuelwood and charcoal, source of supply, means of transport used, duration of supply and seasonal prices a questionnaire is designed to interview the suppliers with details of information such as: age, sex, education, occupation and residential address at different spots (appendix 3).

3.1.2 Data for Household Energy Consumption

Data related to household energy consumption is obtained by conducting household survey through the questionnaire. The questionnaire is designed to generate information pertaining to the sources of supply of household energy's, monthly income and expenditure on traditional and modern forms of energy along with information concerning details of the household such as: size, age and sex of the members, educational level, etc., (Appendix 1)

3.1.3 Field Work

To strengthen the data about the supply of biomass energy and household energy consumption, which is obtained through the questionnaire, field observations and field measurements of biomass fuels has been done wherever the requirement is laid down.

3.2 SAMPLE DESIGNE

Different procedures are used for sample design of biomass energy supply, household energy consumption and field measurement as it can be indicated under sections 3.2.1; 3.2.2 and 3.2.3 below.

3.2.1 Sample Design of Biomass Energy Supply

To determine the amount of inflow of biomass fuels, firstly, 18 spots are selected at suburb/periphry of the town through field observation. Then, these selected spots are identified on the map as well as on the ground by assigning numbers starting from 01, 02, 03 ... to 18. (Fig. 4).

Secondly, to carry out the survey of inflow of biomass fuels, one market day and one non-market day of the week is selected. Beside a form, on which the inflow of different biomass fuel is tallied by assigned enumerators is prepared (see Appendix 2).

Thirdly, one day before biomass energies survey day, orientation and training has been given to the enumerators. Enumerators are assigned to each of 18 selected spots and told to stay on their respective spots for 12 hours (6:00 a.m. to 6:00 p.m.) and observe and tally the required information at an interval of one hour. In this way the data about the amount of inflow of biomass fuel with times and means of transport used are collected.

But because of time constraint only fuelwood and charcoal are treated in sample design of biomass energy sources. To select sample suppliers of fuelwood and charcoal the data is organized according to spot number, time and means of transport used. Thus, proportional allocation according to time and means of transport is used to select sample suppliers from each spot. (see Table 4 and 5).

3.2.2 Sample Design for Household Energy Consumption

From personal experience and field observations of the town it is identified that there is spatial variation between the old and the new settlement areas interms of infrastructural development (housing types and the supply of electric facilities). As a result, purposive sampling is used only to select sample kebeles. Thus, out of 14 kebeles in the town, six kebeles are selected from their different locational setting. That is, kebele 04 and 06 from the center, 02 and 08 from inter-mediate and 09 and 12 from peripheral locations (Fig. 4) whose urban households has been used as a sample frame.

3.2.3 Sample Design of Field Measurement

It was difficult to stop and measure the different biomass fuel supplied at each of the selected spots, field measurements have been done at the market place of the town

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3.2.3 Sample Design of Field Measurement

It was difficult to stop and measure the different biomass fuel supplied at each of the selected spots, field measurements have been done at the market place of the town where the retail as well as whole sale suppliers were readily available. Thus, fuelwood, charcoal, BLT and dung are measured/weighted the moment often the sellers and the consumers had agreed and the selling price was received by sellers from purchasers. Furthermore, three continuous days were used to measure the weight and to list the corresponding prices of the biomass fuels.

3.2 SAMPLE SIZE

3.3.1 Sample Size of Charcoal Suppliers

The inflow survey result of charcoal indicates that on the two survey days, out of 18 inflow observation spots only 9 spots, namely spot numbers, 01, 02, 03, 05, 06, 07, 09 and 10 (Fig. 3.b) were the inlets through which charcoal suppliers were interring the town. The means of transport used were human carriers and pack animals. Thus, children, women, men, donkey and horses are used to transport charcoal to the town.

On the two survey days, the numbers of child, women, men, donkeys and horse interring the town with the load of charcoal were 34, 109, 16, 139 and 1 respectively. Out of these 299 loads only 40 were selected as samples providing, thus, a sample size of 13.4%.

The number of samples proportionally allocated were as 5, 15, 2 and 18 respectively from amongst children, women, men, and donkeys carrying the load. The allocation was further split based the time period at 3 hours interval for the whole day i.e. from 6:00 a.m. to 6:00 p.m. (Table 4).

In case when population is very small, proportional allocation might result in total exclusion of certain item. In such cases the unit item might be selected as a sample in respective of the size decided upon. For example, in case of charcoal the number of horse load was only one. So out of 40 samples, the share of horse load is less than 1 i.e., 0.3% therefore, horse loads as a sample size have been rejected and the whole of 40 samples are allocated proportionally to children women's men and donkeys as shown on Table 4.

Table 4: Allocation of Sample Charcoal Suppliers, According to Means of Transport Used and Time Period

Time Period	Frequency, Means of Transport Used to Supply Charcoal and Sample Size										Total	
	Children		Women's		Men		Donkeys		Horses			
	INF	Sa	INF	Sa	INF	Sa	INF	Sa	INF	Sa	INF	Sa
6:00-9:00	-	-	24	3	11	1	44	6	-	-	79	10
9:00-12:00	28	4	74	10	4	1	80	10	1	-	187	26
12:00-3:00	4	1	10	2	1	-	15	2	-	-	30	4
3:00-6:00	2	-	1	*	-	-	-	-	-	-	3	-
Total	34	5	109	15	16	2	139	18	1	-	299	40

N.B:- INF – Number of Inflow on the two observation days

Sa - Sample Size Used for the Study

Source: Supply of Biomass Energy Survey, January, 2000

3.3.2 Sample Size of Fuelwood Supplies

Unlike charcoal, the supply of fuelwood was observed through all of 18 observation spots. Similar to charcoal, on the two observation days, human fuelwood carriers (children, women's and men) and pock animals (donkeys and horses) were used to transport fuelwood.

The number of children, women's, men, donkeys and horses involved to supply the town were 119, 261, 215, 960 and 25, totally to 1580. Out of the total, due to time constraints, a total of 80 were decided upon to form the samples, providing a sample size of about 5.06%.

In the same way as sample size of charcoal suppliers multi stage stratified random sampling technique was adopted to give proportional allocation to the segments formed based on means of transportation and time period. Thus out of 80 samples, the number of sample size to be taken was 6, 13, 11, 49 and 1 respective to children women's, men, donkeys and horses (Table 5) which was further distributed proportionally according to time to all inlet spots through which fuelwood come to the town.

Table 5: Allocation of Sample Fuelwood Suppliers According to Means of Transport and Time Period

Time Period	Frequency, Means of Transport Used to Supply Fuelwood and Sample Size										Total	
	Children		Women's		Men		Donkeys		Horse			
	INF	Sa	INF	Sa	INF	Sa	INF	Sa	INF	Sa	INF	Sa
6:00-9:00	4	-	15	1	25	2	72	4	3	-	119	7
9:00-12:00	36	2	88	4	44	3	493	25	16	1	677	34
12:00-3:00	47	2	104	5	79	4	354	18	6	-	590	29
3:00-6:00	32	2	54	3	67	3	41	2	-	-	194	10
Total	119	6	261	13	215	11	960	49	25	1	1580	80

N.B:- INF – Number of Inflow on the two observation days
Sa - Sample size used for the study.
Source: Supply of Biomass Energy Survey, January, 2000

3.3.3 Sample Size of Household Energy Consumption

The census results of 1994 indicate that the population of the six purposely selected kebeles (04, 06, 02, 08, 09 and 12) was distributed in 4,966 households each one having 1,093, 975, 685, 536, 1164 and 513 households respectively.

Out of the total 4,966 households of the six kebeles, because of time constraints, only 250 households (about 5.03%) has been used as a sample size for this study, which constituted about 2.36% of the total households in the study area.

To determine the number of sample households to be taken from each sample kebeles, the total sample size (250) is proportionally distributed among the six kebeles. Thus, if the sample of 250 represents 4,966 households in the six kebeles, the number of households to be considered out of 1,093 in kebele 04, for instance, will be 55 (1093 x 250)/4,966. Similarly, the number of households to be considered from kebele 06, 02, 08, 09 and 12 are fixed as 49, 34, 27, 59 and 26 respectively.

There after based on the residential registration and house number of each kebele, systematic random sampling has been used for each kebele.

3.3.4 Sample Size of Biomass Fuels and Field Measurement

To determine the amount of consumption of biomass fuels and also to make conversion and comparison with modern fuels (electricity and kerosen) field measurement has been taken place at market place and where ever it was necessary. Thus, for fuelwood 50 samples, for charcoal (whole sale price 40 samples, retail price 30 samples two types i.e., retailers at market and retailers at shops and street), for

BLT 10 samples were measured with their corresponding prices. But saw-dust was not available for sale at market, as a result only 6 samples measurements had been taken at saw-mills and furniture making enterprises found in the town.

3.4 Conversion of Household Energy Expenditure in to Heat Value

To determine the amount of energy consumed per family per day or month or year, the amount of monthly expenditure reported by sample households has to be converted in to heat value. Though, throughout this study Mega Jule is used to analysis the data interms of heat value.

3.4.1 Conversion of Fuelwood Expenditure into Heat Value

The source of supply for fuelwood were children, women's and men carriers as well as pack animals (donkeys). The price of fuelwood varies between each of these suppliers. Thus, the average price of fuelwood obtained through field measurement was birr 0.17/kg, 0.19/kg, 0.25/kg and 0.21/kg respectively to donkeys, women's, men and children. Similarly the number of sample households purchased fuelwood during the month January, 2000, from each of these suppliers varies in number. Thus, households purchased fuelwood from donkey loads, women's, men and children were 213, 12, 10 and 4 respectively. As a result to determine the common price for conversion process, firstly, the rates (proportion) of families purchasing from each of the suppliers is obtained. Secondly, the proportion of the family purchasing fuelwood from each sources is multiplied by average price obtained from field measurement. Finally, the sum of all products is considered as an average price of fuelwood and used to convert fuelwood to heat value.

Table 6: Proportion of Households Purchased Fuelwood from Different Sources and Average Price of Fuelwood

Households Served	Means of Transport Used				Total
	Donkeys	Women's	Men	Children	
No. of Households	213	12	10	4	239
% of Households	89.12%	5.02%	4.19%	1.67%	100
Ratio of Households	0.8912	0.05 02	0.0419	0.0167	1
Market price of fuelwood	0.17/kg	0.19/kg	0.25/kg	0.21 /kg	
Ratio of HHs x Market price	0.1515	0.0095	0.0104	0.00350	
Average price of fuelwood	0.1749/kg				

Source: Household Survey and Field Measurement February, 2000.

As it is shown on Table 6, 0.17/kg is an average price of fuelwood which is used to convert expenditure into heat value. For instance, if a family make an expenditure birr 10 for fuelwood, 58.82 kg of fuelwood can be bought and by taking a conversion factor (1kg = 14.5 MJ) 852.89 MJ of heat value can be obtained.

3.4.2 Conversion of Charcoal Expenditure into heat Value

The steps and procedures used in the conversion of fuelwood can also be used to convert expenditure mode on charcoal to heat value.

Charcoal was supplied to sample households by whole sellers, retailers at market place and retailers at shape and street. The price at each of these supply sources was birr 0.66/kg, 0.77/kg and 0.86/kg and the number of consumers purchasing from each of these sources were 88,145 and 36 respectively. Therefore; the average price of charcoal as it is shown in Table 7 becomes birr 0.75/kg.

Table 7: Proportion of Households Purchased Charcoal from Different Sources and Average Price of Charcoal

Household Served	Whole Sellers	Retailers at Market	Retailers at Shop & Street	Total
No. of Households	88	145	36	269
% of Households	32.71%	53.91%	13.38%	100%
Ratio (proportion) of Households	0.3271	0.5391	0.1338	1
Market price of charcoal	0.66/kg	0.77/kg	0.87/kg	
Ratio (proportion) of HHs x Market Price	0.2158	0.4151	0.1164	
Average price of charcoal	0.7473/kg			

Source: Household Survey and Field Measurement, January, 2000.

If a family, for instance make an expenditure birr 10 for charcoal, 13.33kg of charcoal can be bought and by taking a conversation factor (1kg = 29 MJ) 386.57 MJ of heat value can be obtained.

3.4.3 Conversion of Expenditure on BLT and Saw-Dust into Heat Value

BLT and saw-dust were purchased from market place and small saw mill enterprises found in the town respectively. Since they were supplied from market and saw mills and also consumed by few households, the average market price of the two birr 0.13/kg, which is obtained from field measurement has been used in conversion process.

Thus, if a family make an expenditure birr 5 for saw dust and birr 2 for BLT, total expenditure made on BLT and saw dust will be birr 7 which is equivalent to 53.85 kg; and by taking (1 kg = 14.5 MJ) 780.825 MJ of heat value can be obtained.

3.4.4 Conversion of Expenditure on Electricity into Heat Value

Ethiopian Electric Power Corporation has electricity energy and service charge tariff category for household sector. That is, each electric customer pay service charge according to electricity consumed in birr/Kwh for each tariff category (see Table 8).

Table 8: Electricity Energy and Service Charge Tariff for Household Sector

Consumption And Service Charge	Tariff Category and Block Identification						
	B L O C K						
	1st	2nd	3rd	4th	5th	6th	7th
Consumption in Kwh	0 - 50	51-100	101-200	201-300	301-400	401-500	> 500
Service charge in birr/Kwh	0.2730	0.2921	0.4093	0.4508	0.4644	0.4820	0.5691

Source: Ethiopian Electric Power Corporation, April, 1998.

From tariff category and block identification given on table 8 the ration of households falling in each tariff category is accessed first, and then the ratio is multiplied by service charge of respective service category. Finally the sum of all products birr 0.2859/Kwh is taken as a service charge to convert expenditure on electricity into heat value.

Table 9: Proportion of Households Making Expenditure on Electricity and Average Price of Electricity/Kwh

Households Served	Tariff Category/Block				Total
	1st	2nd	3rd	4th	
No. of Families	191	30	17	1	239
Percent	79.92%	12.55%	7.113%	0.4184 %	100%
Ratio	0.7992	0.1255	0.7113	0.0041	1
Rate of charge in birr/Kwh	0.2730	0.2921	0.4093	0.4508	
Average price/Kwh for each block	0.2182	0.0367	0.0291	0.0019	
Average price used	Birr 0.2859/Kwh				

Source: Household Survey, February, 2000

If a sample household make an expenditure on electricity birr 5, he can obtain heat value equivalent to 17.49 Kwh or by taking (1 Kwh = 3.6 MJ) 62.964 MJ of heat value can be obtained.

3.4.5 Conversion of Expenditure on Kerosene into Heat Value

Kerosene was available for sale for households from two sources: fuel station and retailers. From field observation it was determined that the price of kerosene was birr 1.55/liter at fuel station and birr 2.25 at retail price. By multiplying the proportion of families served by kerosene from each supply sources and adding the products, the average price of kerosene per liter becomes birr 1.63 (Table 10).

Table 10: Proportion of Households Purchased Kerosene from Different Sources and Average Price of Kerosene

Family Served	Source of Supply		Total
	Fuel Station	Retailers	
No. of Families	162	22	184
% of Families	88.04%	11.96%	100
Ratio of Families	0.8804	0.1196	1
Price respective supply source	1.55	2.25	
Average price (ration of HHS x price at supply)	1.362462	0.2691	
Average price used	1.6337/litter		

Source: Household survey and Field observation, February, 2000.

If the family make an expenditure of 10 birr for kerosene he can purchase 6.13 litter of kerosene and by taking (1 litter = 35.3 MJ), 216.389 MJ of heat value can be purchased.

3.5 HOUSEHOLD INCOME

The households are categorized into five income groups (very low, low, medium, high and very high) based on the mean and standard deviation of monthly income distribution. Thus, the total monthly income of 250 sample households was103,174.89 with an average monthly income and standard deviation of Birr 412.70 and 327.27 respectively. The coefficient of variation 79.30% shows moderately high monthly income disparity and the least and the highest monthly income was Birr 30 and Birr 1715 respectively.

Variation in income is not only found in total distribution, but also within income groups (Table 11) Low income group (Birr 85.43-412.70) with an average monthly income and standard deviation 222.43 and 90.35 respectively is the highest income disparity group with coefficient of variation 40.62%.

Table 11: Sample Households by Income Group and Household size

Income Groups (in Birr)	No. of HHs	Monthly Income	Average Monthly Income	Stand. Deviation	Coff. Variation	Population	Per capita Income	Average HH size
≤85.42	13	765.50	58.88	18.63	31.64%	85	9.00	6.54
85.43-412.70	144	32,029.45	222.43	90.35	40.62%	785	40.80	5.48
412.71-739.96	52	28,360.00	545.38	93.49	17.14%	302	93.91	5.81
739.97-1067.22	33	30,759.94	932.12	87.44	9.38%	143	215.10	4.33
≥ 1067.23	8	11,260.00	14.7.50	180.50	12.82%	50	225.20	6.25
Total	250	103,174.89	412.70	327.27	79.30%	1365	75.59	5.46

Source: Household survey, February, 2000.

The coefficient of variation 31.64 % for very low income group (≤ Birr 85.42) also shows income variation in the group. In the remaining income groups, coefficient of

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≤85.42	13	765.50	58.88	18.63	31.64%	85	9.00	6.54
85.43-412.70	144	32,029.45	222.43	90.35	40.62%	785	40.80	5.48
412.71-739.96	52	28,360.00	545.38	93.49	17.14%	302	93.91	5.81
739.97-1067.22	33	30,759.94	932.12	87.44	9.38%	143	215.10	4.33
≥ 1067.23	8	11,260.00	14.7.50	180.50	12.82%	50	225.20	6.25
Total	250	103,174.89	412.70	327.27	79.30%	1365	75.59	5.46

Source: Household survey, February, 2000.

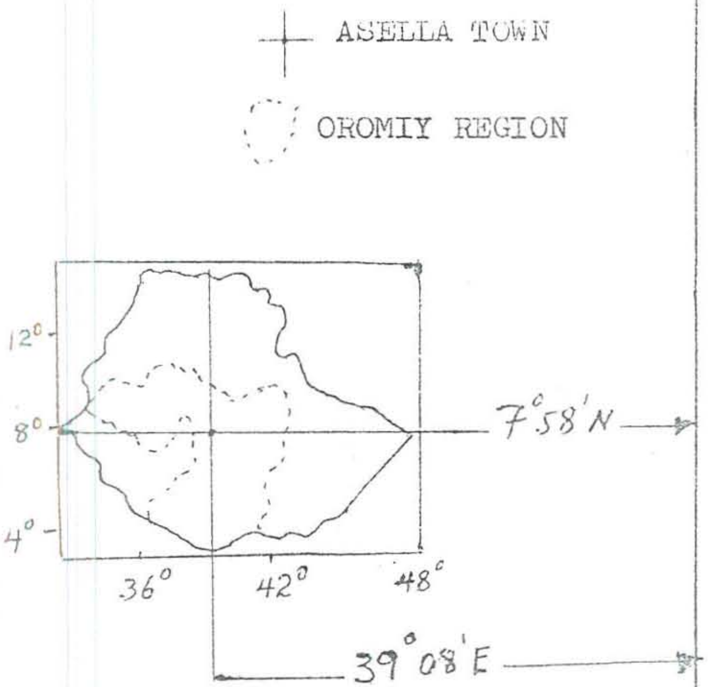
The coefficient of variation 31.64 % for very low income group (≤ Birr 85.42) also shows income variation in the group. In the remaining income groups, coefficient of variation is below 20 % indicating less disparity in income distributions with in the group.

3.6 METHODS OF DATA PROCESSING ANALYSIS AND RESENTATION

In order to make the data contained in the questionnaire suitable for statistical analysis, interpretation and hypothesizing, the information has been processed, classified and tabulated according to the requirements.

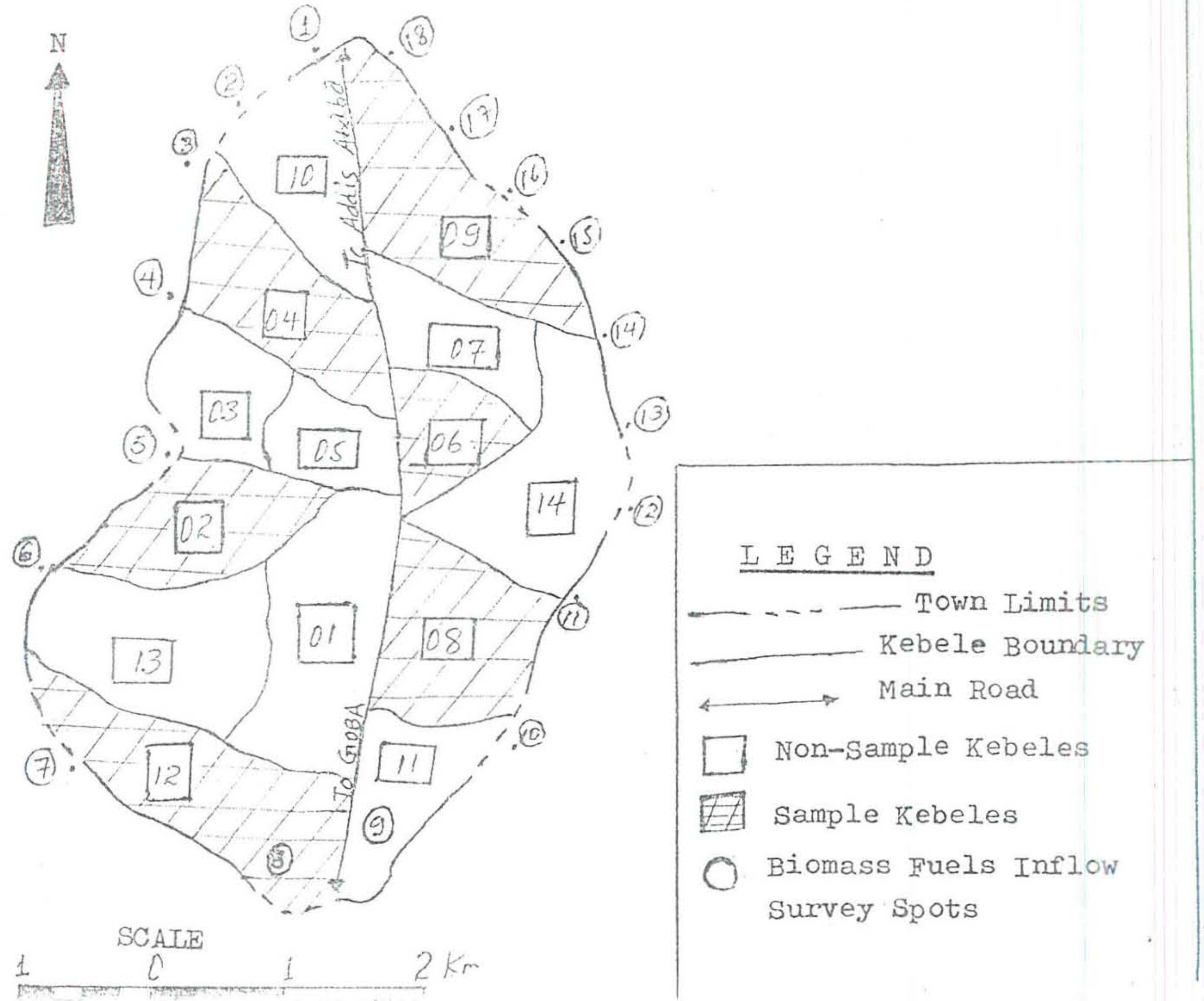
The methodologies employed to analyze the data is both descriptive and inferential statistics. Thus, the organized data in the form of tables, pie chart, maps and graphs has been analyzed/interpreted using descriptive methods. And to test the magnitude of relationship between dependent variables (expenditure on biomass and non-biomass fuels) and independent variables (household income and family size) bi variate and multiple regression analyses has been used.

Fig. 3 LOCATION OF ASELLA TOWN



SCALE :- 1:24,000,000

Fig. 4 Map of Asella Town with Sample Kebeles and Biomass Fuels Inflow Survey Sports



CHAPTER FOUR

CONSTUMPTION AND EXPENDITURE PATTERN OF HOUSEHOLD ENERGY

The analysis and comparison of household energy consumption can be done either in term expenditure of money or on the basis of actual consumption (heat value).

4.1 Expenditure on Household Energy by Income

Expenditure on household energy varies depending upon the economic potential of the household. The information gathered from the questionnaires indicates that the average monthly expenditure on household energy by the sample households is Birr 47.89 per household. When analyzed in respect to income groups it is found that there is variation in expenditure. Thus, the expenditure made by very low, low, medium, high and very high income groups was Birr 12.85, Birr 36.24, Birr 59.09, Birr 81.51 and Birr 102.87 respectively (Table 12).

Similarly, the average expenditure on household energy, as a percentage of household income is Birr 11.60 ranging between 21.82% to 7.31% for very low and very high income groups with successive reduction. Therefore; with increasing household income there is a decline in percent expenditure on household energy although absolute expenditure increase.

Per capita average monthly expenditure on household energy also varies among the various income groups. For the whole of sample households, per capita average expenditure is Birr 8.77 which it varies from as low as Birr 1.96 for very low income group to Birr 16.46 for very high income group.

Table 12: Expenditure on Household Energy by Income Groups

Item	Income Group					Total
	Very Low ≤ 85.42	Low 85.43–412.70	Medium 412.71-739.96	High 739.97-1067.22	Very High ≥ 1067.23	
Number of Households	13	144	52	33	8	250
Total population in the households	85	785	302	143	50	1365
Average family size	6.54	5.45	5.81	4.33	6.25	5.46
Average monthly Household Income	58.88	222.45	545.38	932.12	1407.5	412.70
Average monthly Per Capita Income	9.00	40.81	93.89	215.27	225.20	75.59
Total Expenditure on Household Energy (in birr)	167.05	5219.22	3072.83	2689.76	822.98	11,971.84
Average monthly Expenditure on household energy (Birr)	12.85	36.24	59.09	81.51	102.87	47.89
Average Per Capita Expenditure (Birr)	1.96	6.65	10.17	18.82	16.46	8.77
Expenditure as % of Household Income	21.82	16.29	10.83	8.74	7.31	11.60

Source: Household Survey, February, 2000

4.2 Expenditure on Household Energy by Fuel Types

The total amount of expenditure made on household energy by sample households is Birr 11,971.84. Out of this, Birr 7349.50 (61.39%) and 4622.34 (38.61%) are spent on traditional and modern forms of energies respectively.

4.2.1 Expenditure on Traditional Fuels

Traditional fuels on which expenditure is made by sample households were fuelwood, charcoal and BLT and saw dust which account for 31.23%, 26.96% and 3.20% of the total expenditure on household energy (Table 13).

Total Expenditure on traditional fuels, by various income groups, shows decline with an increasing family income, which can be seen from percent expenditure on traditional fuels. Thus, for low, medium, high and very high income groups percent expenditure on traditional fuels account 67.52%, 61.77%, 53.83% and 46.72% respectively (Table 13) indicating a reduction in the proportion of expenditure on traditional fuels due to the shift to alternative modern fuels with increase in income.

However; for very low income groups expenditure on traditional fuels accounts 56.87% which is a proportion lesser than these by low and medium income groups. This is because their absolute expenditure is very low but absolute expenditure on this aspect can not be reduced proportionately since their rates are fixed. Only some conservation measures can be used to reduce it to some extent.

For example, the total expenditure on electricity and kerosene is Birr 72.05 by very low income group which averages to Birr 5.54 per household only. The absolute expenditure on electricity and kerosene by low, medium, high and very high income groups is 11.77, 22.59, 37.63 and 54.81 Birr per household. Also the traditional fuels might be collected by very low income group families free of charge. Hence they might not have be indicated as expenditure.

Table 13: Percentage Expenditure on Household Energy by Income Groups

Income Group	Expenditure as percent							Grand Total
	Fuelwood	Charcoal	BLT and Saw Dust	Total	Electricity	Kerosene	Total	
≤ 85.42	33.52	14.97	8.38	56.87	23.97	19.16	43.13	100
85.43 – 421.70	37.21	26.55	3.76	67.52	19.19	13.29	32.48	100
412.71 – 739.96	30.36	29.78	1.63	61.77	19.65	18.58	38.23	100
739.97 – 1067.22	24.61	26.54	2.68	53.83	26.30	19.86	46.17	100
≥ 1067.23	17.68	22.84	6.20	46.72	34.62	18.66	53.28	100
Total	31.23	26.89	3.20	61.39	22.03	16.58	38.61	100

Source: Household Survey, February, 2000.

4.2.2 Expenditure On Modern Fuels

The data obtained from sample household survey indicates that the most important modern fuels used for household purposes are electricity and kerosene which togethr accounts 38.61% of the total expenditure of sample household (22.03% electricity and 16.58% Kerosene).

Proportionate expenditure on modern fuels increase with increasing household income ranging from 32.48% by low income group to 53.28% by very high income group which is just opposed to the trends of expenditure on traditional fuels which shows a decline with increasing income (Table 13).

The higher proportion of expenditure on modern fuels by very low income groups as compared to low and medium groups can very well explained by lesser proportion of expenditure on traditional fuels due to free collection (section 4.2.1).

4.3 The Relationship Between Expenditure on Various Types of Energies and Household Size and Household Income

In the analyzing the relationship between dependent and independent variables, expenditure on various household energy (fuelwood, charcoal, electricity and kerosene) taken together and separately are considered as dependent variables while household size and household monthly income are independent variables.

4.3.1 The Relationship Between Total Expenditure On All Household Energy and Independent Variables

The average monthly income of sample households Birr 412.70 with standard deviation 327.27 and the average monthly expenditure on all household energy is Birr 47.89 with standard deviation 24.25 make coefficient of variation 79.30% and 50.64% respectively and indicate high disparity in monthly income as compared to monthly expenditure in the of sample population.

The correlation coefficient (+0.6205) shows total expenditure on all types of household energy is positively correlated with household size and household monthly income. But the degree of correlation differs between household size and household income.

The Multiple coefficient of determination (the proportion of the total variation or variance in total expenditure on all household energy that can be explained by relationship existing between total expenditure, household size and household monthly income is $(0.6205)^{2} \times 100 = 38.5\%$. It means 38.5% of the total variation in the total expenditure on household energy is due to the combined effect of household size and household monthly income and the rest of variation is due to other not included in the analysis.

The Multiple regression equation between total expenditure on household energy , household size and household income is given by :-

$$Y = 22.1878 + 1.5913x_1 + 0.0412x_2 \quad \text{where,}$$

22.1878 = intercept

1.5913 = regression coefficient of x_1 (household size)

0.0412 = regression coefficient of x_2 (household income)

Y = total expenditure

4.3.1.1 The Relationship Between Expenditure On All Household Energy and Household size

The value of correlation coefficient +0.3156 indicates that total expenditure on all household energy has a low correlation or dependent on family size. The coefficient of determination $(0.3156)^2 \times 100 = 9.96\%$ also shows that only less than 10% of the total variation in total expenditure on all household energy is attributed to family size.

The low level of correlation coefficient between total expenditure and family size shows significance variation at 0.05 level of significance because the calculated value of T 5.2378 is greater than the tabulated value 1.960.

The regression equation between total expenditure on household energy and household size is given by: $Y = 30.8178 + 3.1262x$ where,

30.8178 = intercept

3.1262 = regression coefficient of x

x = independent variable (household size)

y = dependent variable (total expenditure)

4.3.1.2 The Relationship Between Expenditure on All Household Energy and Household Income

The value of correlation coefficient +0.6010 shows that total expenditure on all household energy is significantly and positively correlated with household monthly income and the correlation is not the result of chance at 0.05 level of significance, hence, computed T value 11.8425 is greater than the tabulated value 1.960 .

The coefficient of determination $(0.6010)^2 \times 100 = 36.12\%$ of the total variation in the expenditure on all household energy is due to the effect of households monthly income.

The regression equation defining the relationship between total expenditure on various types of energy and household monthly income is given by:

$y = 29.5082 + 0.0445x$ where,

29.5082 = intercept

0.0445 = regression coefficient

x = independent variable (household monthly income)

and y = dependent variable (total expenditure)

Therefore; the equation indicates expenditure on all types of household energy rises with increasing household income.

Table 14: Correlation of Total Expenditure on All types of Household Energy with Independent Variables

Independent Variables	Mean	Standard Deviation	Coefficient of Variation	Correlation x vs y	Regression Coefficient	Standard Error Of Regression coefficient	Computed T Value
Household Size	5.46	2.45	44.87	0.3156	3.1262	0.5968	5.2378
Household Income	412.70	327.27	79.30	0.6010	0.0445	0.0037	11.8425

Mean Expenditure on all Household Energy 47.89 with 24.25 standard deviation

Intercept 22.19

Multiple correlation 0.6205

Standard Error of estimate = 19.09

4.3.2 The Relationship Between Expenditure on Fuelwood and Independent Variables

The data on fuelwood expenditure by sample households indicates that the average monthly expenditure made on fuelwood per household is Birr 14.95 with standard deviation 9.04. Thus, the coefficient of variation 60.47% shows that there is moderate disparity in monthly expenditure on fuelwood among the various income groups.

Expenditure on fuelwood shows fair correlation (+0.4588) with independent variables (household size and household income).

Multiple coefficient of determination indicates that $(0.4588)^{2} \times 100 = 21.05\%$ of the total variation in the expenditure on fuelwood is due to the combined effect of household size and household income and the rest is due to variables not included.

The multiple regression equation between expenditure on fuelwood, household size and household income is given by :-

$Y = 6.0888 + 0.9844x_1 + 0.0084x_2$ where,

6.0888 = intercept

0.9844 = regression coefficient of x_1 (household size)

0.0084 = regression coefficient of x_2 (household income)

Y = Expenditure on fuelwood

4.3.2.1 The Relationship Between Expenditure on Fuelwood and Household Size

Expenditure on fuelwood is poorly correlated with family size r = +0.3520 and the calculated T-Value 5.923 is greater than the tabulated value 1.960 at 0.05 level of significance indicating the correlation between the two variables is significant and it is not due to chance factor.

The coefficient of determination shows that only $(0.352)^2 \times 100 = 12.39\%$ of the total variation on the expenditure on fuelwood can be attributed to household size.

The regression equation defining the relationship between expenditure on fuelwood and household size is given by:

$y = 7.8594 + 1.2993x$ where,

7.8594 = intercept

1.2993 = coefficient of x

x = independent variable (household size)

and y = dependent variable (expenditure on fuelwood)

4.3.2.2 The Relationship Between Expenditure on Fuelwood and Household Income

Expenditure on fuelwood is also poorly correlated with household income (+0.3805) and the calculated T-value 6.4811 is greater than the tabulated value 1.960 so the correlation is not the result of chance at 0.05 level of significance.

The value of coefficient of determination $(0.3805)^2 \times 100 = 14.48\%$ indicates that it is less than 15% of the total variation on the expenditure of fuelwood is attributed to the effect of household income.

The regression equation defining the relation between expenditure on fuelwood and household monthly income is given by:-

$$Y = 10.617 + 0.0105x$$ where,

10.617 = intercept

0.0105 = regression coefficient

x = independent variable (household monthly income)

y = dependent variable (total expenditure on fuelwood)

It means the rate of increase on the expenditure on fuelwood due to increase in household income is 0.0105 unit.

Table 15: Correlation of Expenditure on Fuelwood with Independent Variable

Independent Variables	Mean	Standard deviation	Coefficient Of Variation	Correlation x VS y	Regression Coefficient	Standard Error of Regression Coefficient	Computed T-Value
Household Size	5.46	2.45	44.87	0.352	1.299	0.219	5.923
Household Income	412.70	327.27	79.30	0.381	0.0105	0.001	6.4811

Mean Expenditure on Fuelwood = 14.95 with standard variation = 9.04

Intercept = 6.088

Multiple Correlation = 0.459

Standard Error of estimate = 8.060

4.3.3 The Relationship Between Expenditure on Charcoal and Independent Variables.

The average monthly expenditure made on charcoal is Birr 12.91 with standard deviation 8.96, thus, the coefficient of variation (69.4%) indicates moderate disparity on expenditure made on charcoal by sample households. Multiple correlation coefficient (+0.6167) shows that expenditure on charcoal is positively and moderately correlated with two independent variables (household size and household income).

Multiple coefficient $(+0.6167)^2$ x 100 = 38.03% indicate that about 38% of the total variation in the expenditure on charcoal by sample households can be attributed to the combined effect of household size and household income.

The multiple regression equation between expenditure on charcoal, household size and household income is given by :-

$$Y = 3.3685 + 0.6112x_1 + 0.0150x_2 \quad \text{where,}$$

3.3685 = intercept

0.6112 = regression coefficient of x_1 (household size)

0.0150 = regression coefficient of x_2 (household income)

Y = Expenditure on charcoal

4.3.3.1 The Relationship Between Expenditure On Charcoal and Household size

Poor correlation existed between expenditure on charcoal and household size (+ 0.320). The correlation is not the result of chance because the calculated T-Value 5.3179 is greater than the tabulated value 1.960 at 0.05 level of significance.

The regression coefficient for expenditure on charcoal as related to family size is 1.171, i.e., the rate of increase in the expenditure of charcoal due to per additional member of family is 1.171. Therefore; the regression equation defining the relationship between expenditure on charcoal and household size is given by :

$$Y = 6.516 + 1.171x \quad \text{where,}$$

6.516 = Intercept

1.171 = regression coefficient of x

x = independent variable (household size)

and y = dependent variable (expenditure on charcoal)

4.3.3.2 The Relationship Between Expenditure On Charcoal and Household Income

The correlation between expenditure on charcoal and household income is = 0.5954 and it is not the result of chance at 0.05 level of significance as it is evident from computed T-Value, i.e., 11.672 which is greater than the tabulated value 1.960.

The calculated regression coefficient of expenditure on charcoal correlated with family income is (+0.016) i.e., for a unit rise in income, there is a corresponding rise in expenditure of charcoal by unit 0.016. Therefore; the regression equation defining the relationship between expenditure on charcoal and household income is given by:

$$Y = 6.1805 + 0.0163x$$ where,

6.1805 = Intercept

0.0163 = regression coefficient of x

x = independent variable (household income)

y = dependent variable (expenditure on charcoal)

Table 16: Correlation of Expenditure on charcoal with Independent Variables

Independent Variables	Mean	Standard deviation	Coefficient Of Variation	Correlation X VS y	Regression Coefficient	Standard Error of Regression Coefficient	Computed T-Value
Household Size	5.46	2.45	44.87	0.320	1.171	0.220	5.3179
Household Income	412.70	327.27	79.30	0.595	0.0163	0.001	11.672

Mean Expenditure on charcoal = 12.91 with standard deviation = 8.96

Intercept = 3.368

Multiple correlation = 0.6166

Standard Error of estimate = 7.083

4.3.4 The Relationship Between Expenditure on Electricity and Independent Variables

Multiple correlation between expenditure on electricity and independent variables (household size and household income) is +0.5913, which means with rise in household size and household income there is also an increase on the expenditure of electricity. Multiple coefficient of determination $(0.591)^2 \times 100 = 34.93\%$ indicate that total variation in the expenditure on electricity by sample households is effected by household size and household income to the extent of 34.93%.

The multiple regression equation between expenditure on electricity, household size and household income is given by :-

$$Y = 0.7775 + 0.2685x_1 + 0.0201x_2$$ where,

0.7775 = intercept

0.2685 = regression coefficient of x_1 (household size)

0.0201 = regression coefficient of x_2 (household income)

Y = Expenditure on electricity

4.3.4.1 The Relationship Between Expenditure on Electricity and Household size

Expenditure on electricity is positively but weakly correlated with household size (+ 0.217). But the correlation is not the result of chance factor at 0.05 level of significance, because the calculated T-Value 3.496 is for greater than tabulated value 1.960 required for significance in the correlation.

The calculated regression coefficient when expenditure on electricity as correlated with family size is 1.018 i.e., the ratio of increase in expenditure on electricity due to per additional increase in family member is 1.018. Therefore; the regression equation defining the relationship between expenditure on electricity and family size is given by:-

$$Y = 4.992 + 1.018x \quad \text{where,}$$

4.992 = Intercept

1.018 = regression coefficient of x

x = independent variable (household income)

y = dependent variable (expenditure on electricity)

4.3.4.2 The Relationship Between Expenditure On Electricity and Household Income

The expenditure made on electricity is significantly correlated with family income (+ 0.5887) which indicates that increase in household income is followed by corresponding increase in the amount of expenditure made on electricity. This correlation is not the result of chance factor, hence, computed T-Value (11.4718) is greater than the tabulated value 1.960 at 0.05 level significance.

The regression coefficient when expenditure on electricity is correlated with household income is 0.02068 and the regression equation defining the relationship between expenditure on electricity and income is given by:

$$Y = 2.0128 + 0.02068\,x \text{ where,}$$

2.0128 = Intercept

0.02068 = regression coefficient of x

x = independent variable (household income)

and y = dependent variable (expenditure on electricity)

Table 17: Correlation of Expenditure on electricity with Independent Variable

Independent Variables	Mean	Standard Deviation	Coefficient Of Variation	Correlation x VS y	Regression Coefficient	Standard Error of Regression Coefficient	Computed T-Value
Household Size	5.46	2.45	44.87	0.217	1.018	0.291	3.496
Household Income	412.70	327.27	79.30	0.589	0.020	0.001	11.472

Mean Expenditure on Electricity = 10.55 with standard deviation = 6.82

Intercept = 0.7775

Multiple correlation = 0.591

Standard error of estimate = 1.944

4.3.5 The Relationship Between Expenditure on Kerosene and Independent Variables

Multiple correlation between expenditure on kerosene and independent variables (household size and household income) is +0.5702 which shows with increasing household size and household income, there is corresponding increase on the expenditure on kerosene. Multiple coefficient of determination $(0.5702)^2 \times 100 =$ 32.51% indicate that variation in the expenditure on kerosene by sample households is explained by the two variables: household size and household income to the extent of 32.51%.

The multiple regression equation between expenditure on kerosene, household size and household income is given by :-

$$Y = 0.2437 + 0.3715x_1 + 0.0137x_2 \quad \text{where,}$$

0.2437 = intercept

0.3715 = regression coefficient of x_1 (household size)

0.0137 = regression coefficient of x_2 (household income)

Y = Expenditure on kerosene

4.3.5.1 The Relationship Between Expenditure on Kerosene and Household Size

Expenditure on kerosene is poorly correlated (0.2553) with household size, however, the correlation is not the result of chance at o.o5 level of significance because the computed T-Value 1.960 is above the tabulated value 1.960 required for significance in correlation.

The regression coefficient for expenditure on kerosene as related to household size is 0.8827 i.e., the rate of increase in the expenditure of kerosene due to per additional member of family is 0.8827. The regression equation defining the relationship between expenditure on kerosene and household size indicates an increase in family (household) size results in a insignificant increase on the expenditure of kerosene. Thus, the equation is defined by : y = 3.1179 + 0.8827x where,

3.1179 = intercept

0.8827 = regression coefficient of x

x = independent variable (household size)

and y = dependent variable (expenditure on kerosene)

4.3.5.2 The Relationship Between Expenditure On Kerosene and Household Income

Expenditure on kerosene is positively and significantly correlated (+0.5608) to household income. That is, increase in family income is followed by corresponding increase in the amount of expenditure on kerosene. And the correlation is not the result of chance factor at 0.05 level of significance, hence, the calculated T-Value 10.667 is for greater than the tabulated value 1.960.

The regression coefficient for expenditure on kerosene as related to household income is 0.0145 i.e., a unit increase in family income results 0.0145 unit increase on the expenditure of kerosene. Thus, the regression equation defining the relationship between expenditure on kerosene and household income is given by

Y = 1.9529 + 0.0145x where,

1.9529 = intercept

0.0145 = regression coefficient of x

x = independent variable (household size)

and y = dependent variable (expenditure on kerosene)

Table 18: Correlation of Expenditure on Kerosene with Independent Variables

Independent Variables	Mean	Standard Deviation	Coefficient Of Variation	Correlation x VS y	Regression Coefficient	Standard Error of Regression Coefficient	Computed T-Value
Household Size	5.46	2.45	44.87	0.255	0.883	0.212	4.159
Household Income	412.70	327.27	79.30	0.561	0.0145	0.001	10.667

Mean Expenditure on kerosene = 7.94 with standard deviation = 5.13

Intercept = 0.437

Multiple correlation = 0.570

Standard Error of estimate = 6.979

4.4 Total Consumption of Household Energy

The total amount of monthly household energy consumption, interms of heat value, by sample households is 556,219.54 MJ and the average monthly consumption per household is 2224.89 MJ, which varies among the various income groups. The monthly consumption per household is 650.11 MJ, 1847.35MJ, 2667.05MJ 3368.41 MJ and 3988.20 MJ respective to very low, low, medium, high and very high income groups (Table 19). This shows that with rise in household income there is an increase in amount of energy consumption per household.

Average monthly per capita consumption of the various types of household energy for the whole of sample households is 407.49 MJ which also varies according to the variation in household income. Thus, except very high income groups in which the average is less than the preceding group, per capita consumption generally increases with increasing income (Table 19).

Table 19: Average Monthly Total Consumption of Household Energy by Income Groups

Income Group (in Birr)	No. of sample Households	Population	Average households size	Average household Income (Birr)	Total Consumption (in MJ)	Monthly Energy Consumed (MJ)	
						Per Household	Per Capita
≤ 85.45	13	85	6.54	58.88	8451.47	650.11	99.41
85.46 – 412.70	144	785	5.45	222.45	266,018.17	1847.35	338.96
412.71 –739.95	52	302	5.81	545.38	138,686.53	2667.05	459.04
739.96 – 1067.20	33	143	4.33	932.12	111,157.74	3368.41	777.92
≥ 1067.20	8	50	6.25	1407.5	31,905.63	3988.20	638.11
Total	250	1365	5.46	412.70	556,219.54	2224.89	407.49

Source: Sample Household Survey, February, 2000

4.5 Household Energy Consumption by Fuel Types

The total amount of household energy consumed by the whole sample households, interms of heat value, is 556,219.54 MJ/month but of this amount the share of traditional fuels and modern fuels is 480,124.92 MJ (86.32%) and 76,094.62 MJ (13.68%) respectively.

4.5.1 The Consumption of Traditional Fuels

Traditional fuels together accounts 86.32% of the total household energy consumption interms of heat value (fuelwood 57.33%, charcoal 21.30% and BLT & Saw dust of 7.69%) or 66.41%, 24.68% and 8.91% of the total traditional fuels consumed respectively.

The consumption of fuelwood decreases with increasing household income, however, for very low income groups the percentage share of fuelwood in total consumption (56.52) is less than the consumption of fuelwood for the whole samples as well as the immediate following low income class. This is partly due to the supply pattern of fuelwood which is generally met through free collection by household members.

On the other hand, with rise in household income there is an Increase in the consumption of charcoal. This is because of its high thermal value per unit weight (29 MJ/kg), availability, cleanness (smokeless), storability, etc.

However, the peak share charcoal consumption is by the medium income groups. This is mainly due to the shift to other alternative i.e., modern fuel such as electricity and kerosene by the high and very high income group family. In general as far as the consumption of traditional fuels is concerned, fuelwood is the most important followed by charcoal, BLT and saw dust (Table 20).

4.5.2 The Consumption of Modern Fuels.

The consumption of modern fuels by sample households accounts for 13.68% of the total (5.97% electricity and 7.71% kerosene). Decline in the consumption of traditional fuels with an increasing income is reflected by corresponding rise in the consumption of modern fuels (both electricity & kerosene) with rise in income. But free collection of fuelwood by very low income groups introduce some discrepancy in the general trend.

In general, like the consumption of charcoal but unlike the consumption of fuelwood, the consumption of electricity and kerosene increases with increasing income. Which speak of the shift towards more efficient household fuels i.e., electricity and kerosene (Table 20).

Table 20: Contributions of Traditional and Modern Fuels In Total Consumption of Household Energy (percent)

Income Group (in Birr)	Traditional Fuels				Modern Fuels			Grand Total
	Fuelwood	Charcoal	BLT and Saw-Dust	Total	Electricity	Kerosene	Total	
≤ 85.45	56.52	10.86	18.48	85.86	5.96	8.18	14.14	100
85.49 – 412.70	62.27	19.12	8.24	89.63	4.74	5.63	10.37	100
412.71 – 739.95	57.38	24.22	4.02	85.62	5.48	8.90	14.38	100
739.96 – 1067.20	50.80	23.58	7.22	81.60	8.02	10.38	18.40	100
≥ 1067.21	38.90	21.63	17.83	78.36	11.24	10.40	21.64	100
Total	57.33	21.30	7.69	86.32	5.97	7.71	13.68	100

Source : Household Survey, February, 2000.

4.6 Per Capita Consumption

The variation noticed in monthly household energy consumption by fuel types and income is also reflected on per capita consumption of traditional and modern fuels.

4.6.1 Per Capita Consumption of Traditional Fuels

The average per capita consumption of traditional fuels for the hole of sample population in woodfuel equivalent is 24.26 kg/ persons/month which comes to an annual consumption of woodfuel per capita 291.10kg. However, this monthly and annual per capita consumption differs very significantly among the various income groups. Thus, per capita consumption for very low income groups is 5.89 kg/month or 70.63kg/year while for high income group it is 43.75 kg/month or 524.94 kg/year (Table 21).

In general, except for very high income class where the per capita woodfuel equivalent of traditional fuels shows decline, due to the shift to modern fuels; per capita consumption increases with increasing income.

Table 21: Monthly and Annual Per Capita Consumption of Traditional Fuels in Kg. of Woodfuel Equivalent

Income Group	No. of HHs	Total pop. In HHs	Average HH Size	Total Consumption of Traditional Fuels (in MJ/month)	Average monthly Consumption per HHs (in MJ/month)	Per Capita Consumption		
						Woodfuel In kg/month MJ	Woodfuel In kg/month	Woodfuel In kg/year
≤ 85.42	13	85	6.54	7,255.73	588.13	85.34	5.89	70.63
85.43 – 412.70	144	785	5.45	238,418.62	1655.68	303.72	20.95	251.35
412.71 – 739.96	52	302	5.81	118,7441.94	2283.56	393.20	27.12	325.40
739.97 –1067.22	33	143	4.33	90705.61	2748.65	634.30	43.75	524.94
≥ 1067.23	8	50	6.25	25,000.02	3215.00	500.00	34.48	413.79
Total	250	1365	5.46	480,124.92	1920.50	351.74	24.26	291.10

Source: Sample Household Survey, February, 2000.

4.6.2 Per Capita Consumption of Modern Fuels

Electricity and kerosene as modern fuels are measured in different units. Therefore; for better comparison of per capita consumption, they are treated separately in kwh and liter under section 4.6.2.1 and 4.6.2.2.

4.6.2.1 Per Capita Consumption of Electricity

The average per capita consumption of electricity for the whole of sample population is 6.76 kwh/person/month which would be 81.11 kwh/ person/year. But this amount of per capita consumption varies among the various income groups and with increasing household income per capita consumption of electricity also increases.

Thus, very low income groups consumes only 1.65 kwh/person/month or 19.77 kwh/person/month or 239.18 kwh/ person/year while very high income group consumes 19.93 kwh/ person/month or 239.18 kwh / person/year (Table 22).

Table 22: Monthly and Annual Per Capita Consumption of Electricity in KWH

Income Group	No. of HHs	Total pop. In HHs	Average HH Size	Total Consumption of Traditional Fuels (in MJ/month)	Average monthly Consumption per HHs (in MJ/month)	Per Capita Consumption		
						In MJ/month	In kwh/ Month	In kwh/ year
≤ 85.42	13	85	6.54	504.30	38.79	5.93	1.65	19.77
85.43 – 412.70	144	785	5.45	12,611.58	87.58	16.07	4.46	53.57
412.71 – 739.96	52	302	5.81	7602.69	146.21	25.17	6.99	83.88
739.97 –1067.22	33	143	4.33	8909.46	269.98	62.35	17.32	207.84
≥ 1067.23	8	50	6.25	3587.79	448.47	71.76	19.93	239.18
Total	250	1365	5.46	33,215.84	132.86	24.33	6.76	81.11

Source: Household Survey, February, 2000

4.6.2.2 Per Capita Consumption of Kerosene

Per capita consumption of kerosene for the whole of population in sample households is 0.89 liter/ person/month which makes the annual per capita consumption of 0.68 liter/ person/year, which it varies between various income groups from 0.23 liter/person/month in very low income group to 2.29 liter/person/month in high income group. Except in very high income group where per capita kerosene consumption declines as compared to the immediate preceding income group, per capita consumption of kerosene generally increases with increasing income (Table 23).

Table 23: Monthly and Annual Per Capita Consumption of Kerosene in Liter

Income Group	No. of HHs	Total pop. In HHs	Average HH Size	Total Consumption of Kerosene (in MJ/month)	Average monthly Consumption per HHs (in MJ/month)		Per Capita Consumption	
					In MJ/Month	In liter / Month	In liter/ month	In liter / year
≤ 85.42	13	85	6.54	691.44	53.18	1.51	0.23	2.76
85.43 - 412.70	144	785	5.45	14987.97	104.08	2.95	0.54	6.49
412.71 – 739.96	52	302	5.81	12338.90	237.29	6.72	1.16	13.88
739.97 –1067.22	33	143	4.33	11542.67	349.78	9.91	2.29	27.46
≥ 1067.23	8	50	6.25	3317.82	414.73	11.75	1.88	22.56
Total	250	1365	5.46	42878.80	171.52	4.86	0.89	10.68

Source : Households Survey, February, 2000.

CHAPTER FIVE

SUPPLY OF BIOMASS FUELS AND THE CHARACTERISTICS OF THE SUPPLIERS

5.1 1The Supply of Biomass Fuels and Means of Transport

The inflow survey results of biomass fuels on one market day and one non-market day indicates that different biomass fuels are supplied by different means of transport to town. The types of biomass fuels supplied except agri-residues, which is not used as a fuel, are fuelwood, charcoal, BLT, tree roots and dung. And the means of transport used to supply are human labour (women, men and children) and pack animals (donkeys and horses).

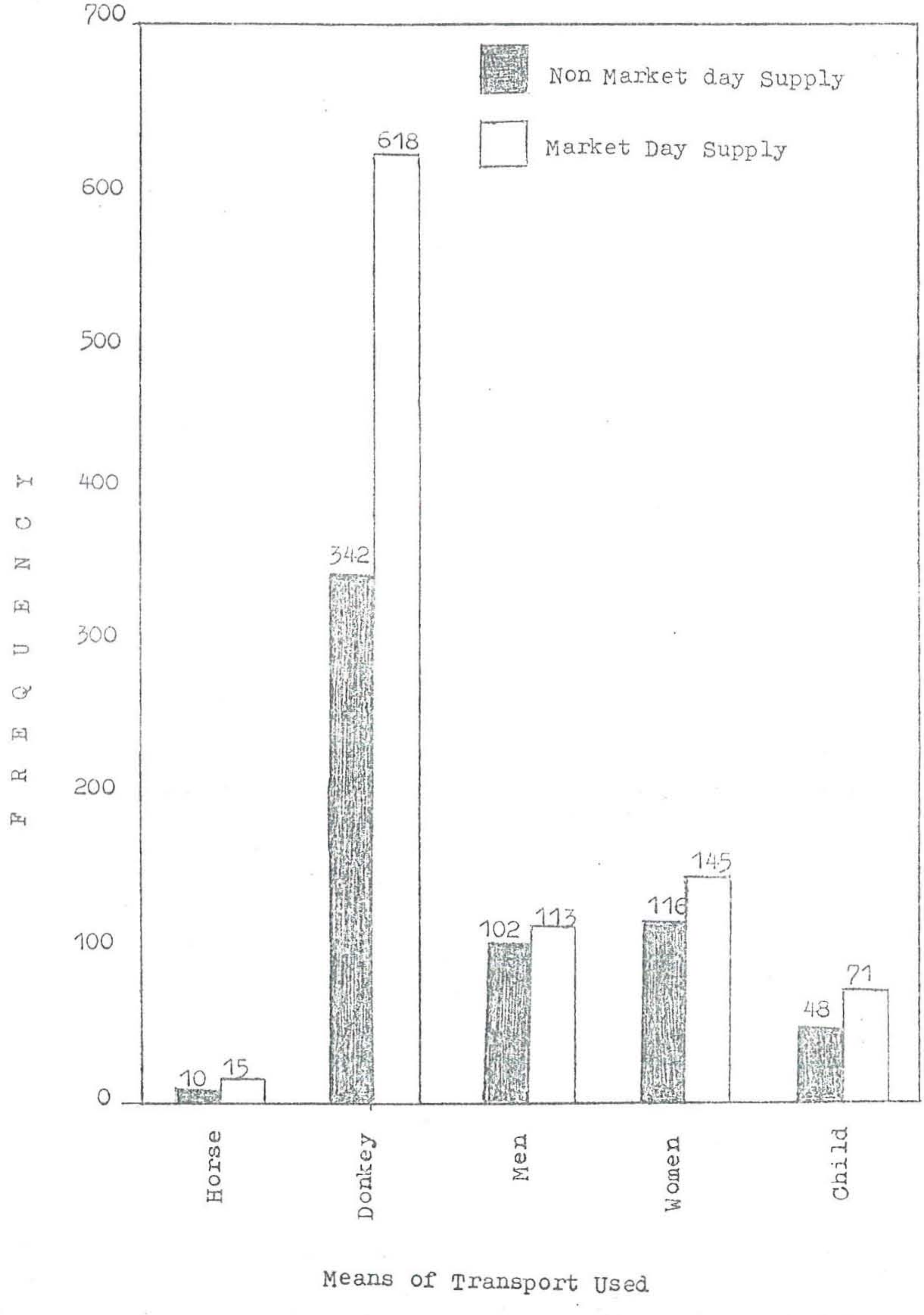
5.1.1 Supply of Fuelwood

The inflow of fuelwood during the two days and the means of transport used to supply are shown in figure 5. The figure indicates, that on the two survey days, the dominant means of transport used to supply fuelwood was donkeys, followed by women's, men and children. The use of horse as a means of transport is very small. Figure 5 also shows the supply is lesser on market days particularly the supply variation is more marked in the use of donkeys.

5.1.2 Supply of Charcoal

As in case of inflow of fuelwood, charcoal is also supplied by human load as well as pack animals. The inflow survey result of charcoal supply is shown in

Fig. 5 Supply of Fuelwood by Means of Transport Used



Source: Field Survey, Jan., 2000

figure 6. The number of donkey load inflow of charcoal is more as compared to the number of women's, men, children and horse. The reduction in the number of loads is more pronounced between market and non market days (35.9% of the market days). It is, however strange that more men carry the loads on non market days than on market day.

5.1.3 Supply of BLT

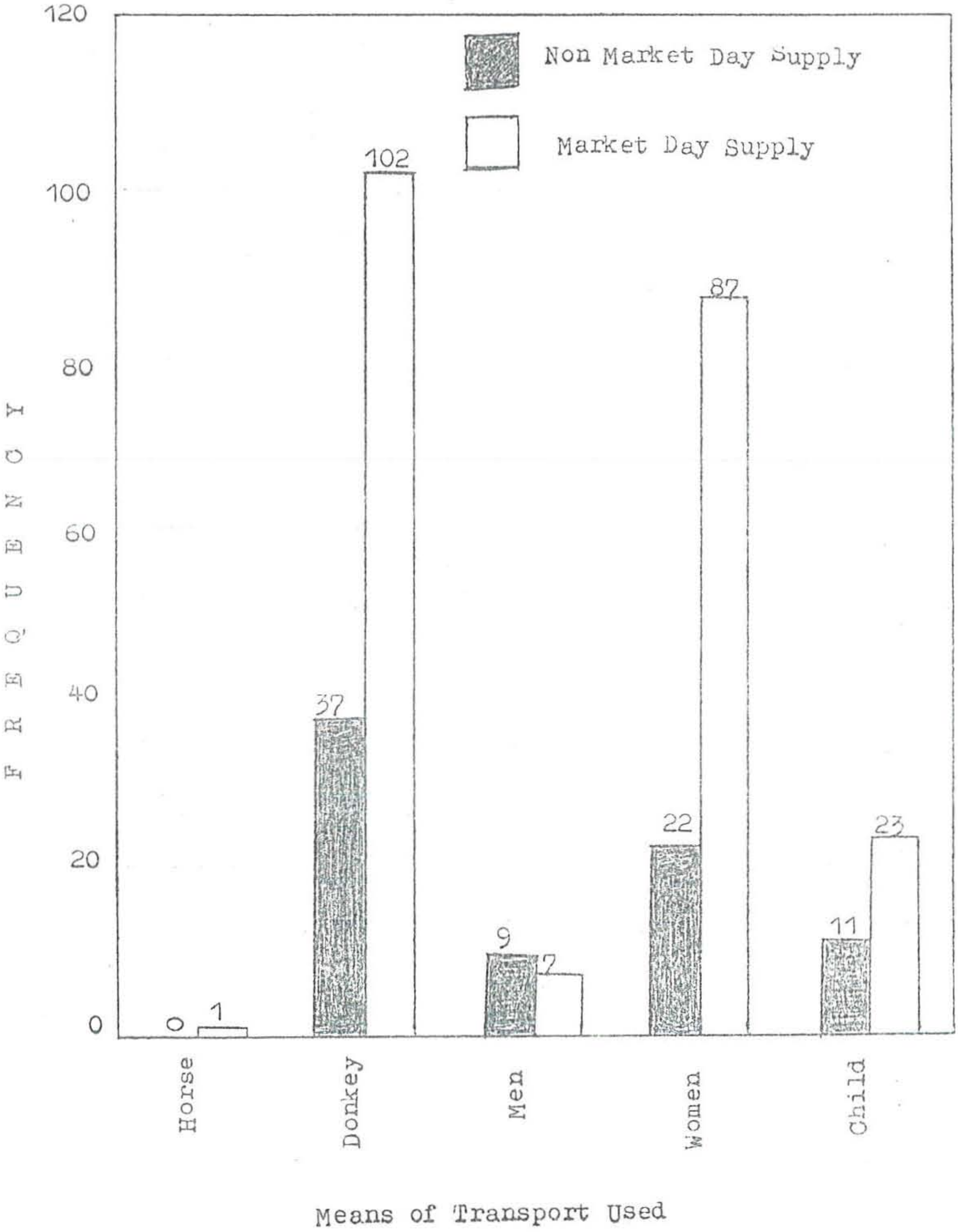
The inflow of BLT (branches, leaves and twigs), which is supplied separately or mixed together, indicates that human labour is the most important means of transport used to supply BLT (see Figure 7). Of all human labour involved in supply of BLT, child labour is the leading followed by women's and men. The contribution of pack animal (donkey and horse) is very small.

Unlike the supply of fuelwood and charcoal, the supply of BLT is almost equal on market and non market days. This may be due to:-

Firstly, BLT is mainly obtained from suburbs and from peasant associations surrounding Asella town at shorter distances through free collection,

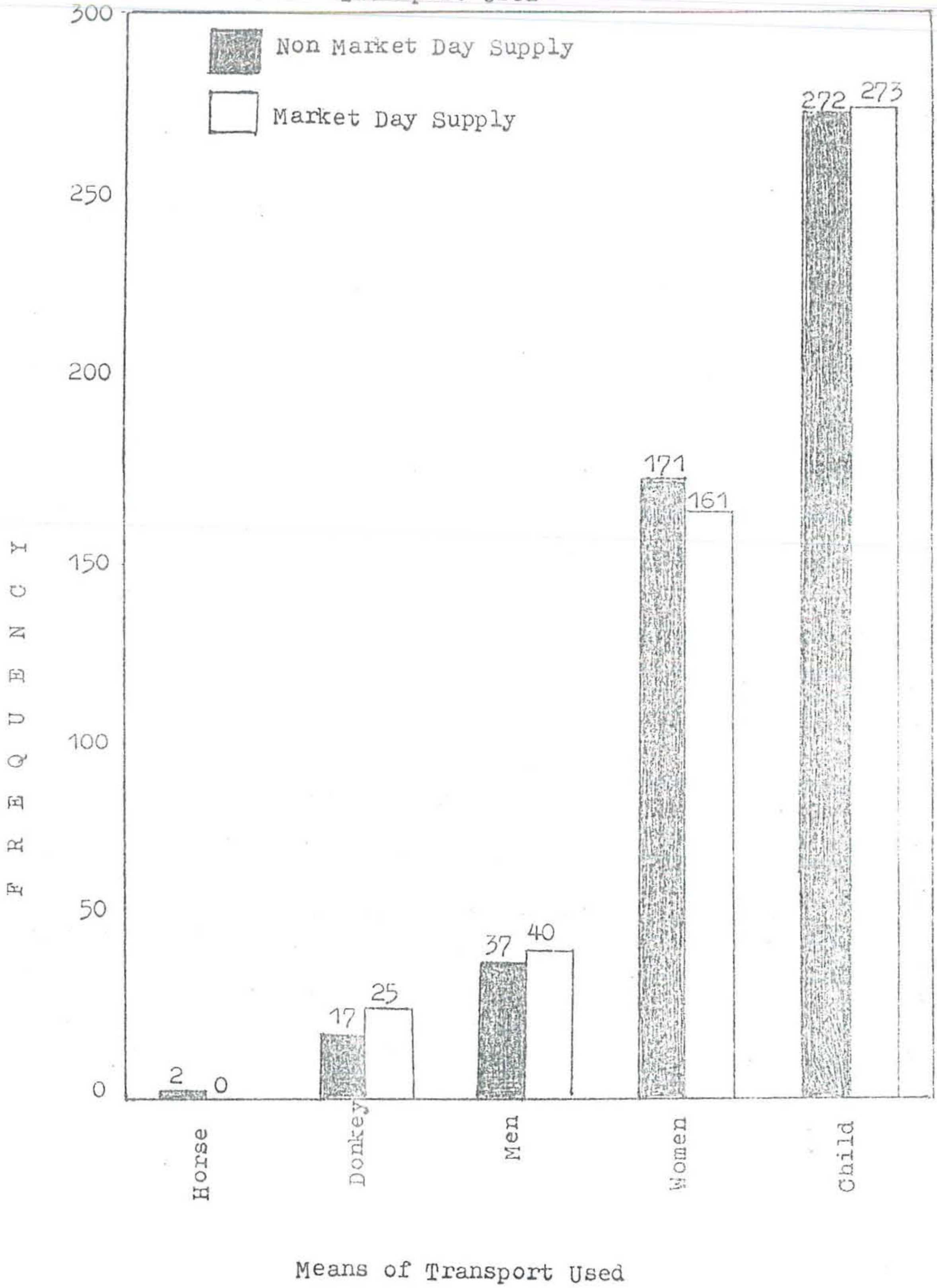
Secondly, from market survey and observation of Asella town, though BLT is supplied for sale by few suppliers, large portion of the inflow is directly used by supplier (collector) for own household use.

Fig. 6 Supply of Charcoal by Means of Transport Used



Source: Field Survey, Jan., 2000

Fig. 7 Supply of BLT by Means of Transport Used



Source : Field Survey, Jan. 2000

5.1.4 Supply of Dung

The inflow of dung on the two days showed that it is the least supplied biomass fuel. And also during the three consecutive biomass fuels measurement days at the market no more than 5-10 dung sellers were observed at the market place.

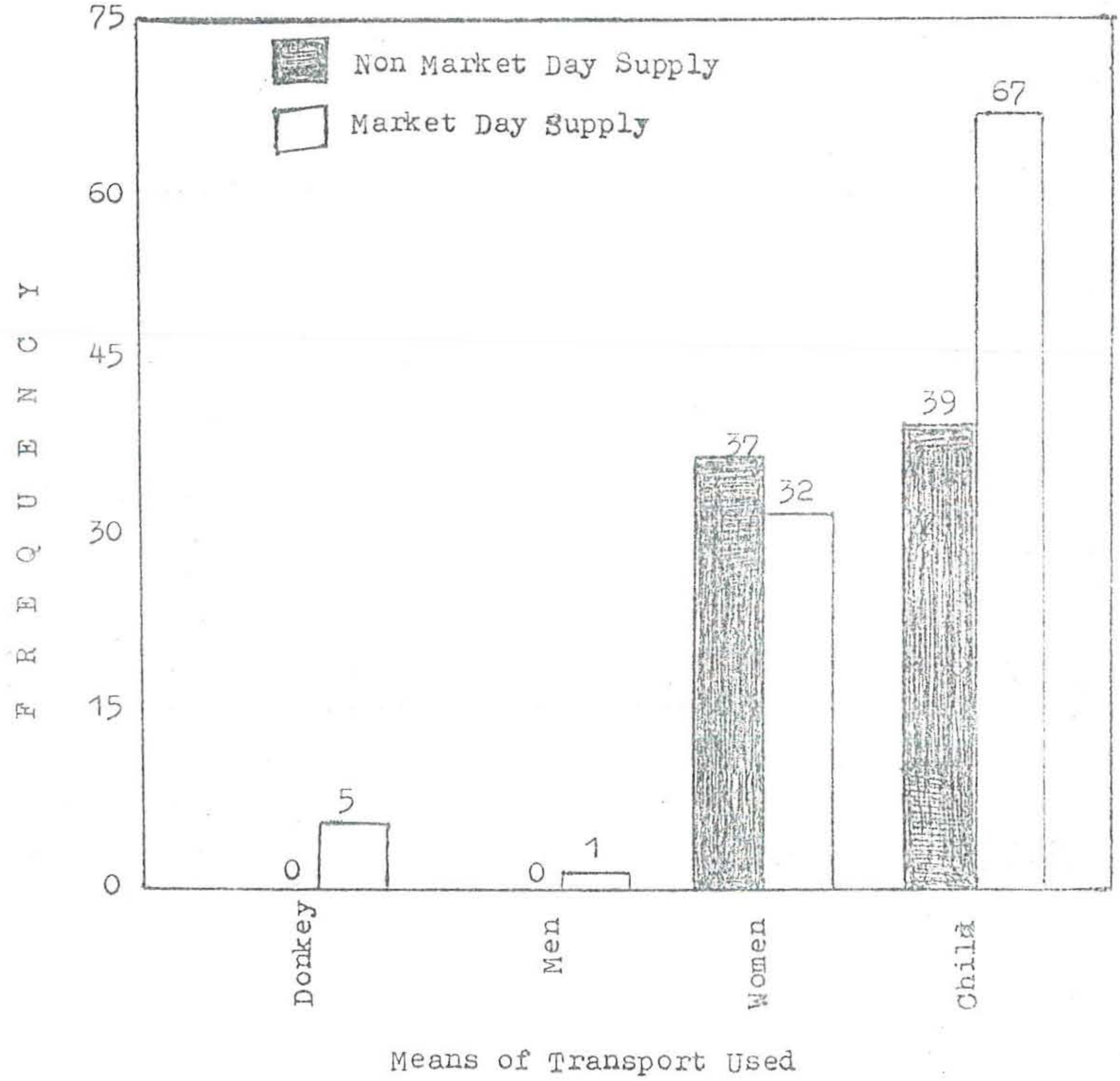
The transportation and supply of dung is mainly by human labour in general, by children and women labour in particular. Thus, more than 50% and 30% of dung supply on the two days was by children and women carriers respectively. Curiously enough the number of women suppliers was more on non market day while the number of all other suppliers decline. Contribution of other means say men, donkeys and horse is insignificant on both of days (Fig. 8).

Similar to BLT, dung is also obtained through free collection from grazing grounds found in the suburbs and near by peasant associations of Asella town. The collected dung was generally used by collectors for their own household consumption, thus, its commercial importance is very low.

5.1.5 Supply of Tree Roots

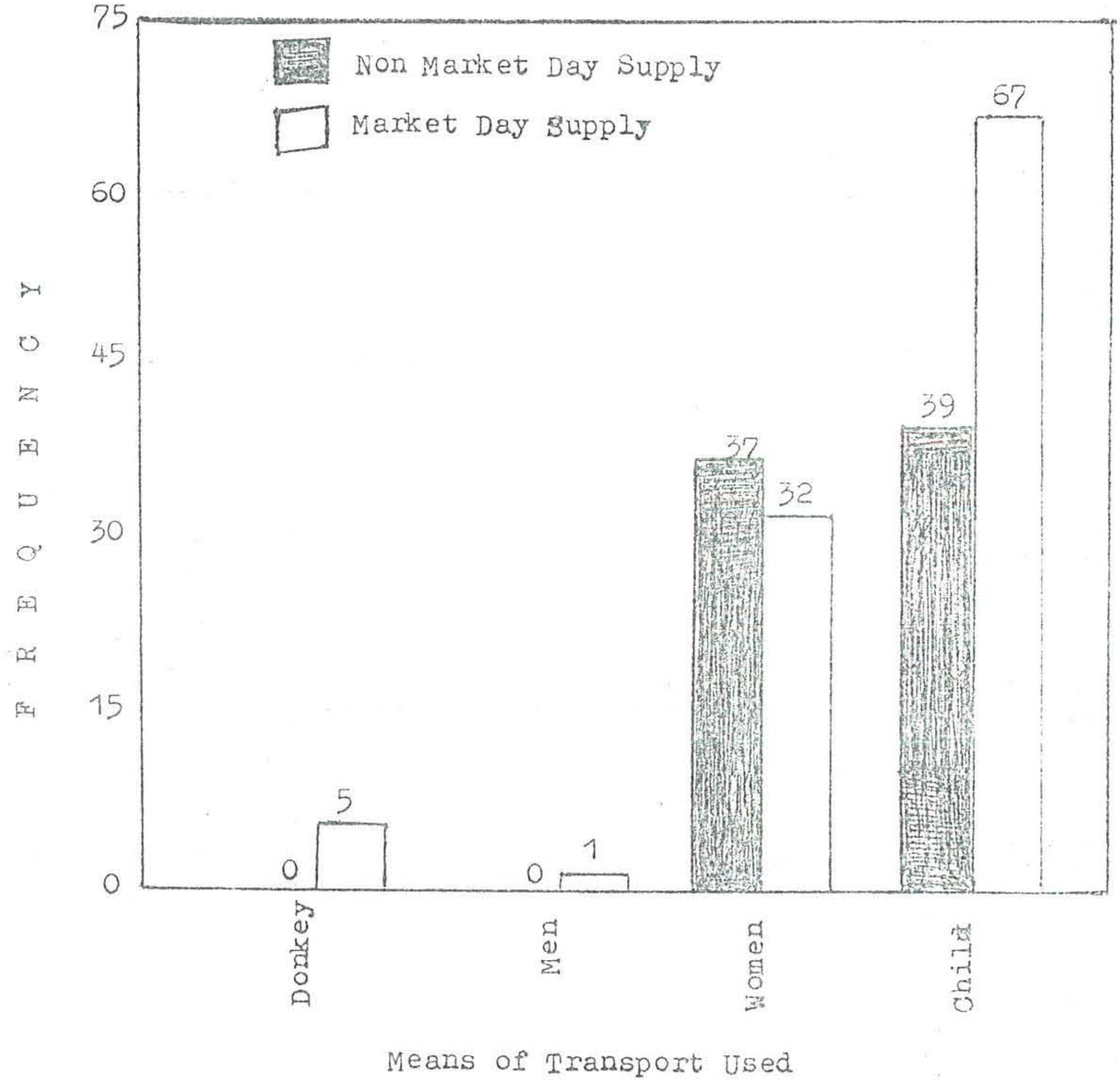
Tree roots, chopped into pieces and packed in different sizes also supplied through different entry points.

Fig. 8 Supply of Dung by Means of Transport Used



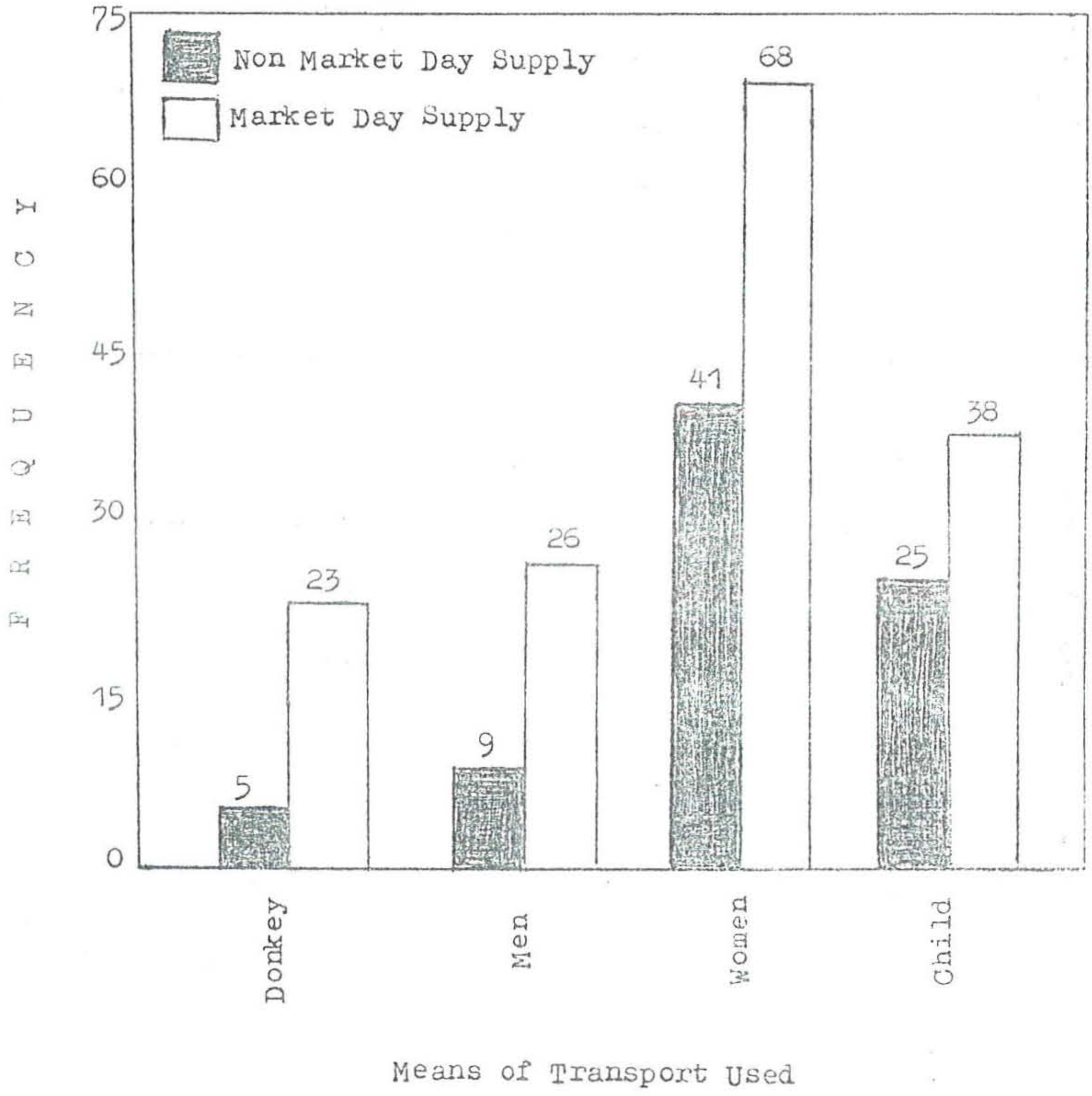
Source : Field Survey, Jan. 2000

Fig. 8 Supply of Dung by Means of Transport Used



Source : Field Survey, Jan. 2000

Fig. 9 Supply of Tree Roots by Means of Transport Used



Source : Field Survey, Jan., 2000

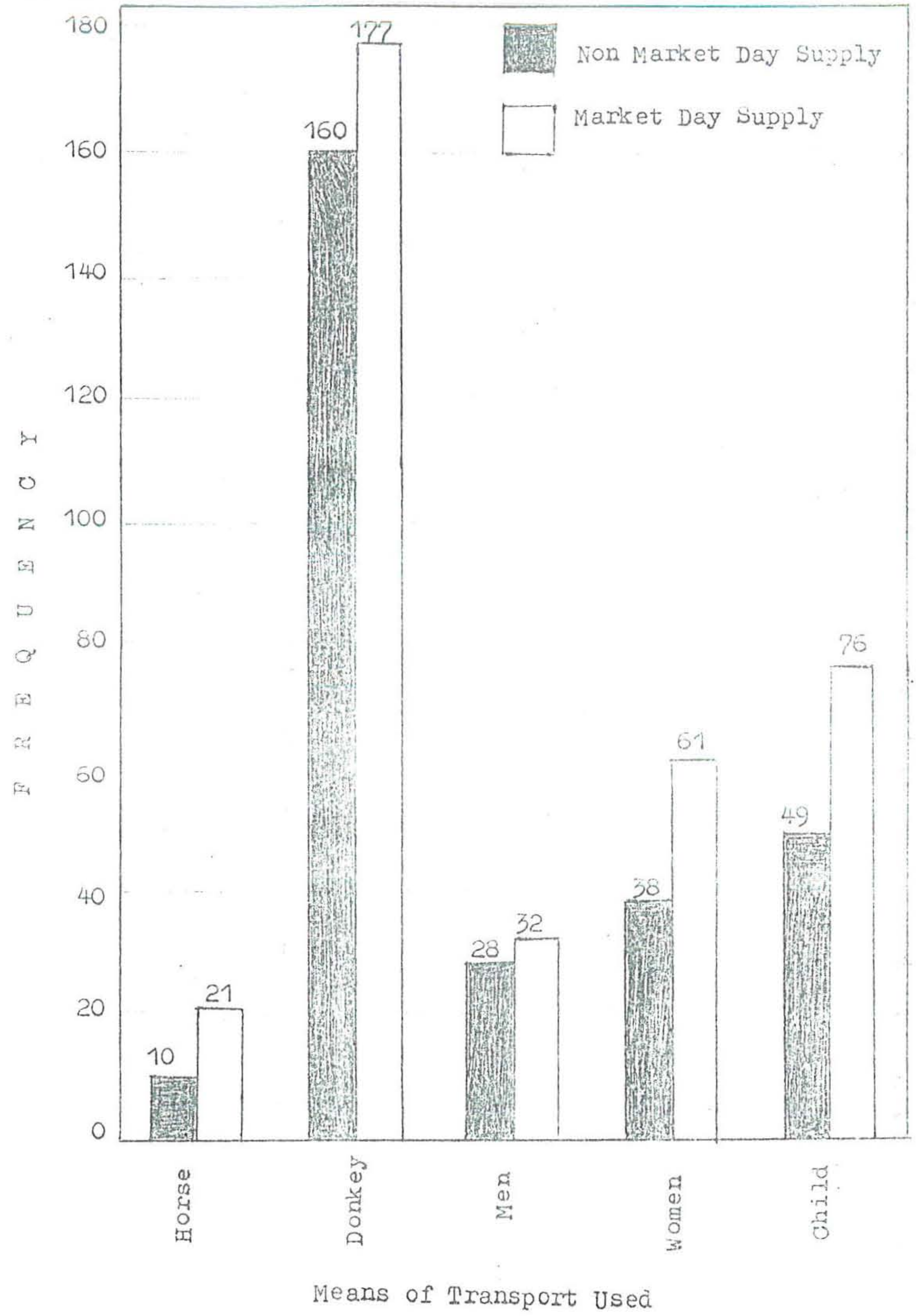
Human carriers here also dominates as a means of transport to supply tree roots. Women tree root suppliers on market and non-market day were 68 and 41, while children and men were 38 and 25 and 26 and 9 respectively. Donkey is the only animal carrier for tree roots and the number was 23 and 5 on market and non market day respectively (Fig. 9).

5.1.6 Supply of Agri-residues

The most important agri-residues supplied are that of teff, wheat and barly. Although the total number of loads by different means of transport involved in the supply of agri-residues is exceedingly greater as compared to the supply of charcoal, dung and tree root supply, its importance as a source of household energy in the study area is negligible. But it is of greater commercial value as it is need more for animal feed, construction of house (house wall) and also for making setting and sleeping mattresses.

Figure 10 shows the supply of agri-residues on the two days and the means of transport used. As shown is the figure, agri-residue is supplied more by pack animals, particularly donkeys, rather than human carriers. And of all supply of agri-residues by human labour, the involvement of child labour is greater followed by women's and then men's. The figure also indicates, the inflow of agri-residues by all means of transport used is more on market day than the non-market day.

Fig. 10 Supply of Agri-residues by Means of Transport Used



Source : Field Survey, Jan. 2000

5.2 Energy Inflow from Woodfuel

Here it will be tried to establish the equivalence of woodfuel in terms of MJ for the purpose of comparison with other energies used. That is why energy inflow is used in this section.

Energy inflow from the supply of woodfuel, for Asella town, is calculated by combining the data collected from supply of biomass fuel survey which can be quantified by weight and by using the measurement of loads carried by children, women, men and donkey including horse as well as according to the number of market and non market days in a week.

The town has three market days in a week, Saturday, Tuesday and Thursday the rest are non-marketing days. Therefore, assuming the amount of supply for 3 market days and 4 non-market days is constant, the amount of energy inflow from charcoal and fuelwood can be calculated for the month January, 2000.

Table 24: Frequency of Supply of Charcoal and Fuelwood by

Different Means of Transport

Means of Transport	Survey Day	Means of Transport (carriers)	
		Charcoal	Fuelwood
Children	MD	23	71
	N.MD	11	48
	Total	34	119
Women	MD	87	145
	N.MD	22	116
	Total	109	261
Men	MD	7	113
	N.MD	9	102
	Total	16	215
Donkey and Horse	MD	103	633
	N.MD	37	352
	Total	140	985

Source: Sample survey of Biomass fuel supply January, 2000

MD = Market Day

N.MD = Non market day

5.2.1 Energy Inflow from Charcoal

The data collected through sample field measurement of charcoal indicates that the average load of charcoal carried per child, women, men and donkey was 11.43 kg, 23.81 kg, 29.5 kg and 44.50 kg respectively. To calculate energy inflow from charcoal, the following conversion factors are used.

The conversion factors

One kg. of charcoal = 29 MJ = 8.055 Kwh = 0.008055 Mwh

One kwh	=	3.6 MJ
One Mwh	=	1000 Kwh

The total supply of charcoal by different carriers was 4517.03 kg/day or 45.1703 quintal/day (see Table 25). Using the conversion factors given above, the daily energy inflow from charcoal equals 130,993.87 MJ/day or 36,387.186 Kwh/day or 36.387 Mwh/day. Similarly, energy inflow from charcoal for month January 2000 would be 4,060,810.00 MJ or 1,128,002.8 Kwh or 128.00 Mwh.

Table 25: Daily Energy Inflow From Charcoal

		Means of Transport (carriers)			
		Child	Women	Men	Donkey*
*1 Quantity of Inflow by Carriers	MD	23	87	7	103
	N-MD	11	22	9	37
*2 Expected Inflow by Carriers	MD	69	261	21	309
	N-MD	44	88	36	148
Total weekly inflow by carriers		113	349	57	457
*3 Average load of the carrier		11.43kg	23.81kg	29.5kg	44.5kg
Weekly supply by carriers		1291.59kg	8309.69kg	1681.5kg	20,336.5kg
Average Daily supply by carriers		184.51kg	1,187.10kg	240.21kg	2,905.21kg
% (Percent)		4.10	26.39	5.34	64.17
Total Daily Supply		4517.03 kg/day			

* - including the horse load
MD - Market day
N-MD - Non-market day
*1 - Obtained from biomass fuel inflow survey
*2 - MD inflow x 3 days, N-MD inflow x 4 days
*3 - Obtained from sample field measurement.

5.2.2 Energy Inflow from Fuelwood

The weight load obtained from field measurements of fuelwood suppliers was on an average 11.97kg, 25.68kg, 43.43 kg and 36.08 kg. respectively per child, women, men and donkey loads (Table 26). To calculate energy inflow in modern units from fuelwood supply, for month of January, 2000, the conversion factor used was one kg. of fuelwood (air dry) equal to 14.5 MJ. Therefore, Kwh and Mwh equivalent of one kg. of fuelwood is 4.0277 and 0.004027 respectively.

Table 26: Daily Energy Inflow From Fuelwood

		Means of Transport (carriers)			
		Child	Women	Men	Donkey*
*1 Quantity of Inflow by Carriers	MD	71	145	113	633
	N-MD	48	116	102	352
*2 Expected Inflow by Carriers	MD	213	435	339	1899
	N-MD	192	464	408	1408
Total weekly inflow by carriers		405	899	747	3307
*3 Average load of the carrier		11.97kg	25.68kg	43.43kg	36.08kg
Weekly supply by carriers		4847.85kg	23086.32kg	32442.21kg	119316.56kg
Average Daily supply by carriers		692.55kg	3298.05kg	4634.60kg	17045.22kg
% (Percent)		2.70	12.85	18.05	66.40
Total Daily Supply		25,670.42 kg/day			

* - including the horse load
MD - Market day
N-MD - Non-market day
*1 - Obtained from biomass fuel inflow survey
*2 - MD inflow x 3 days, N-MD inflow x 4 days
*3 - Obtained from sample field measurement.

As it can be seen from Table 30, the average daily supply of fuelwood by different carriers was 25,670.42 kg which is equivelent to 372,221.09 mJ/day or 103,392.75

Kwh/day or 103.38 Mwh/day. Thus the total energy inflow from fuelwood for the month of January, 2000 would be about 3,205,175.30 Kwh or 3204.78 Mwh.

In general, excluding other traditional biomass energy sources, the amount of energy inflow from wood fuel (charcoal and fuelwood) for the month January, 2000 amounted to about 3,332.78 Mwh.

5.2 Characteristics of Charcoal and Fuelwood Suppliers

5.3.1 Age Structure of the Suppliers

Age structures of the sample charcoal and fuelwood suppliers show that more than 90% of both charcoal and fuelwood suppliers are between age of 10-49 (Table 27). Most of charcoal and fuelwood suppliers (40%) are found between age of 20-29. Separately, out of 40 and 80 sample charcoal and fuelwood suppliers' age group 20-29 accounts for 25.0% and 47.5% respectively.

Table 27: Age Structure of Charcoal and Fuelwood Suppliers

	Charcoal		Fuelwood		Woodfuel	
Age Group	No	%	No	%	Total	%
< 10 year	-	-	-	--	-	-
10-19 years	11	27.5	18	22.5	29	24.2
20-29 years	10	25.0	38	47.5	48	40.0
30-39 years	9	22.5	11	13.8	20	16.7
40-49 years	7	17.5	10	12.5	17	14.20
≥ 50 Years	3	7.5	3	3.7	6	5.0
Total	40	100	80		120	100

Source: Sample Survey of Charcoal and Fuelwood Suppliers, February, 2000.

Second to age group 20-29, age group 10-19 years accounts 27.5% and 22.5% of charcoal and fuelwood suppliers respectively but 24.2% of both the suppliers.

Age groups 30-39 and 40-49 years stands the 3rd and 4th which accounts 22.5% and 17.5% charcoal suppliers and 13.8% and 12.5% of fuelwood suppliers and 20(16.7%) and 17(14.2%) of both suppliers respectively. No charcoal a fuelwood suppliers are found below the year of 10. The number of suppliers aged 50 and above accounts 7.5% of charcoal and 3.7% of fuelwood suppliers and 6(5.0%) of both (woodfuel) suppliers.

In general, age groups 10-19 and 20-29 together account for more than 60% of woodfuel suppliers. It is also observed that with increasing age the number of suppliers' decline in all the cases.

5.3.2 Residential Address of the Suppliers

The whole of charcoal suppliers are from outside Asella town while 17(21.3%) of the fuelwood suppliers are residing permanently in Asella (Table 28). The reason why the whole of charcoal suppliers are not from Asells town is charcoal is mainly supplied through commercial channel from further distance, therefore, some of resident of Asella are not engaged in direct supply of charcoal, but act as a middle men and retailers of charcoal.

Table 28: Residential Address of Charcoal and Fuelwood Suppliers

Permanent Residential Address	Charcoal		Fuelwood		Total	%
	No	%	No	%		
In Asella Town	-	-	17	21.3	17	14.2
Outside Asella Town	40	100	63	78.7	103	85.8
Total	40	100	80	100	120	100

Source: Sample Survey of Charcoal and Fuelwood Suppliers, February, 2000.

Together more than 85% of sample suppliers are from outside the town mainly because they have easy access to sources of supply.

5.3.3 Educational Level of the Suppliers

Educational characteristics of charcoal and fuelwood suppliers indicates that more than 50% of the suppliers are illiterate. Thus, out of 120 suppliers interviewed 64(53.3%) are illiterate out of these 46(71.9%) are females and 18(28.1%) are males (Table 29).

Table 29: Educational Level and Sex of Sample Suppliers

Educational Level	Sex		Total	%
	Males	Females		
Illiterate	18	46	64	53.3
Read and Write	7	9	16	13.3
Grade 1-4	19	6	25	20.8
Grade 5-8	10	4	14	11.7
Grade 9-12	1	-	1	0.8
Total	55	65	120	100

Source: Sample Survey of Charcoal and Fuelwood Suppliers, February, 2000.

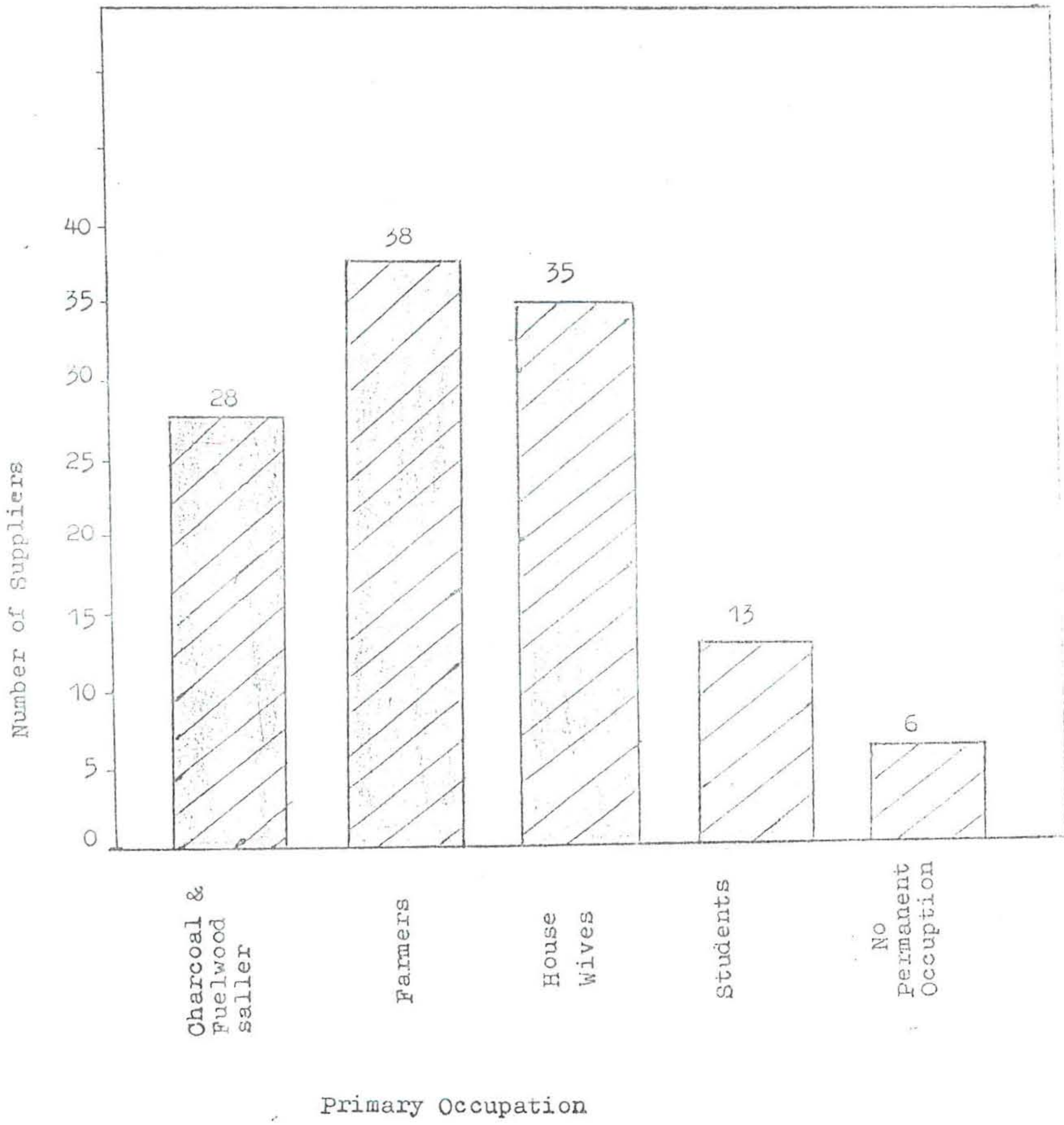
Sample suppliers having the ability to read and write accounts for 16(13.3%) out of which 9(56.3%) are females and 7(47.7%) are males. And suppliers at educational level between grade 1-4, 5-8 and 9-12 account for 25(20.8%), 14(11.7%) and 1(0.8%) of the total suppliers respectively. These categories are dominated by males (75%) as against the other two categories having no formal education where females constitutes 68.8% of the total samples of suppliers (Table 29).

5.3.4 Occupational Characteristics of the Suppliers

The supply of woodfuel might be taught of as an exclusive means of livelihood, but the survey concerning this research indicates it is a secondary occupation to supplement ones earnings. Thus, beside people solely engaged in supply of charcoal and fuelwood, farmers, house wives, students etc. are also involved in the occupation of supply (Fig. 11)

As it is indicated in the figure 13 out of 120 sample charcoal and fuelwood suppliers only 28(23.3%) are persuading the activity as their permanent occupation and means of livelihood while 6 (5%) are those who do not have any permanent job. The remaining 86 (71.7%) are engaged this occupation as a secondary activities. That is, farmers as suppliers of charcoal and fuelwood constitute the largest proportion 38 (31.7%) followed by a house wives 35 (29.2%) and students 13 (10.8%). Thus it obvious that woodfuel supply activity is not persuade only the people as exclusive occupation.

Fig. 11 Occupation of Sample Charcoal and Fuelwood Suppliers



Source : Sample Survey, Feb., 2000

5.4 Source of Woodfuel

Sample suppliers were asked as to how do they obtain charcoal and fuelwood for supply to Asella town. The response concerning the sources were varied such as cutting their own tree stands, buying trees, cutting from wood lands, collecting from wood lands, cutting and collecting from wood lands and buying charcoal or fuelwood for re-sale. Succeeding paragraphs will be devoted to the analyses of the response obtained.

5.4.1 Means of Obtaining Charcoal

Half (20) of the sample charcoal suppliers responded that they bought charcoal from charcoal markets found around and near by their residential areas to re-sale in Asella town (Table 30).

Table 30: Means of Obtaining Charcoal to Supply Asella town

No	Means of Obtaining Charcoal	Total	%
1	Cutting own stand tree and making it charcoal	1	2.5
2	Buying stand tree and making it charcoal	2	5.00
3	Collecting from woodlands and making it charcoal	9	22.5
4	Cutting from woodlands and making it charcoal	2	5.0
5	Collecting and cutting from woodlands and making it charcoal	6	15.0
6	Buying charcoal from other market places	20	50.0
Total		40	100

Source: Sample Survey of Charcoal and Fuelwood Suppliers, February, 2000.

Only 2.5% of suppliers prepared charcoal from their own tree stands and 5% by buying trees from others. Remaining 42.5% prepared charcoal either by collecting wood from woodlands or by cutting wood from wood lands or by collecting and cutting wood from wood lands.

5.4.2 Means of Obtaining Fuelwood

Responses of more than half 49 (60%) of the sample fuelwood suppliers indicated that they obtained fuelwood freely through collecting, cutting or and cutting and collecting from woodlands. About a quarter of suppliers 19 (23.75%) cut and sale their own trees as fuelwood while 10 (12.5%) purchase the tree and cut and sale it as fuelwood. The supplier engaged in buying and re-selling of fuelwood are the least i.e., only 2.5% (Table 31).

Table 31: Means of Obtaining Fuelwood to Supply Asella Town

No	Means of Obtaining	Total	%
1	Cutting own tree for fuelwood	19	23.75
2	Buying stand tree to sale it as a fuelwood	10	12.50
3	Collecting from woodlands	19	23.75
4	Cutting from woodland	10	12.50
5	Cutting and collecting from woodlands	20	25.0
6	Buying fuelwood for re-sale it for profit	2	2.50
Total		80	100

Source: Sample Survey of Charcoal and Fuelwood Suppliers, February, 2000.

5.5 Source of Origin of Woodfuel

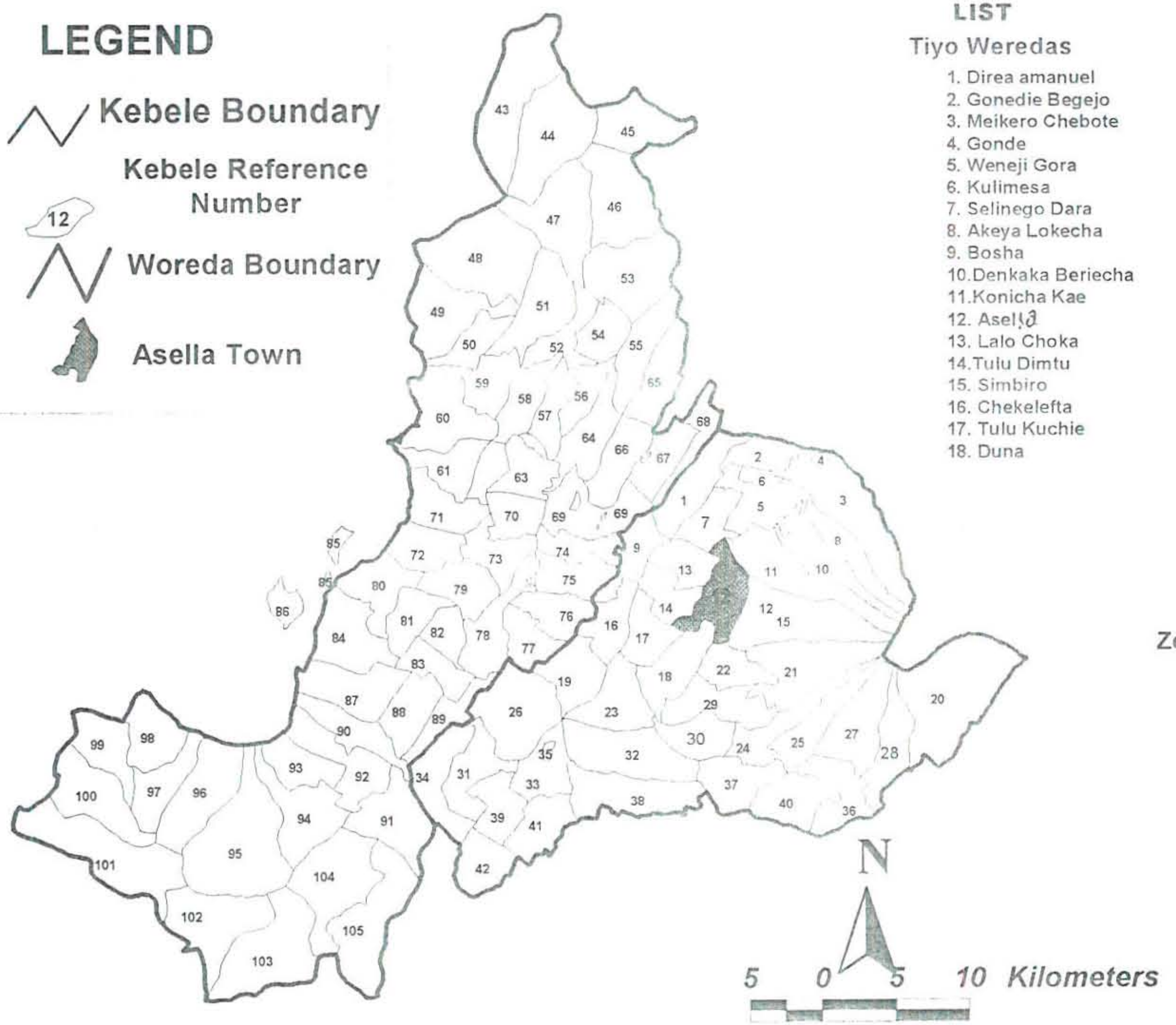
The sample survey of woodfuel suppliers to Asella town shows that fuelwood and charcoal are supplied from the peasant associations and small villages of only two weredas of Arsi administrative zone which are Tiyo (in which Asella town is located) and Zeway-Dugda. But because of spatial variation in distances, accessibilites and availability of forest resources all peasant associations and villages are not equally important as a source of supply.

5.5.1 Source of Origin of Charcoal

Out of 40 total charcoal suppliers 30 (75%) are from Tiyo wereda and the remaining 10 (25%) are from Zeway-Dugda wereda (Table 32). The spatial distribution of peasant associations or origin shows that all the suppliers come from West, South and South East. The sample survey of charcoal suppliers indicates Dugeda peasant association, of Zeway Dugeda wereda, is the leading source of charcoal supply sharing 9(22.5%) of the total.

The Peasant Association Ketaregenate 01 which is in Tiyo wereda is the second largest origin of charcoal suppliers 6(15.0%) of the total. As many as 4(10%) suppliers reported the origin of charcoal Dosha Peasant Association, neighbouring Asella town, and 3(7.5%) each come from Bilao and Kula Peasant Associations and Keteregenate village, all are from Tiyo wereda. Waji Chebeti and Aleltu Shala Peasant Associations from Tiyo wereda each accounts for 2(5%) sample suppliers.

Fig. 12 LIST OF KEBELES IN TIYO AND ZEWAY DUGDA WEREDAS



LIST

Tiyo Weredas

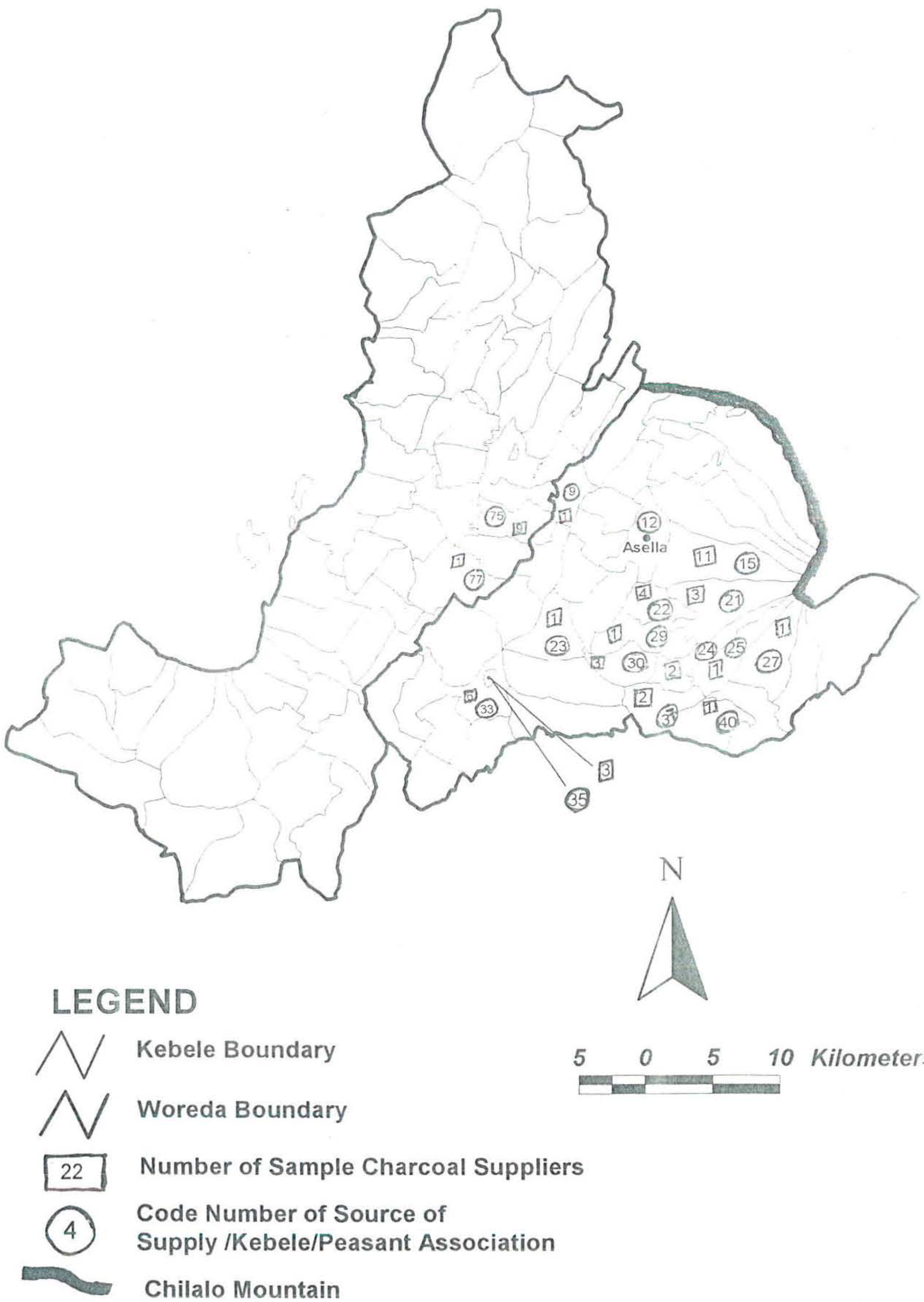
1. Direa amanuel
2. Gonedie Begejo
3. Meikero Chebote
4. Gonde
5. Weneji Gora
6. Kulimesa
7. Selinego Dara
8. Akeya Lokecha
9. Bosha
10. Denkaka Beriecha
11. Konicha Kae
12. Asella
13. Lalo Choka
14. Tulu Dimtu
15. Simbiro
16. Chekelefta
17. Tulu Kuchie
18. Duna
19. Dugda Michael
20. Beriti Sherefee
21. Kula
22. Dosha
23. Gebiha
24. Aleltu Shala
25. Beriti Shala
26. Figasha Borera
27. Beriti Kora
28. Lukie Sherefee
29. Ealena
30. Bilalo
31. Murekicha
32. Aleltu Chebi
33. Ketaregenate01
34. Aburie Kobo
35. Katare Genete
36. Waji Beriti
37. Waji Chebieti
38. Abichu
39. Aleko Bomebi
40. Kechema Shuka
41. Abosera Aleko
42. Goja

Zeway Dugda Weredas

43. Bite Daba
44. Tube Wekie
45. Dabobiesa Bitie
46. Areba Bitie
47. Boka
48. Wadesa Meja
49. Netelie Shenene
50. Netelie Meneche
51. Lemefo
52. Oda
53. Hula Areba
54. Weridie
55. Ariba Korminie
56. Korebie
57. Ubo Wieni
58. Ubo Harageda
59. Senego
60. Golebie
61. Adulala
62. Doya
63. Hallo
64. Endode
65. Toyoadanebie
66. Demitu Deneba
67. Bushie Deneba
68. Debie Deneba
69. Demitu Raretie
70. Shelede
71. Chopa
72. Gasera
73. Goto
74. Arata Chufa
75. Dugeda
76. Dugda Chefie
77. Tatesa Batu
78. Uneshiti
79. Dodobo
80. Hierera
81. Buchamo
82. Koyansho Diera
83. Koyansho Sedin
84. Harerie Mendeyo
85. Tedecha
86. Tulu Gudo
87. Kombolcha
88. Kiyansho Kebota
89. Kobo Berera
90. Lalo
91. Kochie
92. Goro
93. Roro
94. Chafoe Jelia Zuria
95. Ewellio
96. Awaro Fitu
97. Liekenesho
98. Sodacha
99. Dodocha
100. Goleba
101. Hulo Aluto
102. Haroresa
103. Kelbo
104. Aderieliepo
105. Borie
106. Ogolcho

Source: South-Eastern Rural Development Project (Asela, 2000)

Fig. 13 NUMBER OF CHARCOAL SUPPLIERS BY KEBELES/PEAS
ASSOCIATIONS



Source: Field Survey, Feb. 2000.

One Peasant Association, Tatesa Batu, of Ziway-Dugda wereda and seven Peasant Association Ealena, Beriti Shala, Beriti Kora, Simbiro, Chebiha, Kechema Shuka and Bosha of Tiyo wereda each of them accounts one supplier as an origin of charcoal (Table32 and Fig.13).

Table 32: Source of Supply of Charcoal and Means of Transport Used

No	Source of Supply	Wereda	Code No. on Fig 20	Means of Transport				Total	%
				Child	Women	Men	Donkey		
1	Dugeda	Ziway-Dugeda	75	-	-	-	9	9	22.5
2	Ketaregenate 01	Tiyo	33	-	-	-	6	6	15.0
3	Dosha	"	22	-	4	-	-	4	10.0
4	Kula	"	21	1	1	-	1	3	7.5
5	Bilalo	"	30	1	1	-	1	3	7.5
6	Ketare Genete	"	35	-	-	-	3	3	7.5
7	Waji Chebieti	"	37	1	1	-	-	2	5.0
8	Aleltu Shala	"	24	-	1	-	1	2	5.0
9	Ealena	"	29	1	-	-	-	1	2.5
10	Biriti Shala	"	25	-	1	-	-	1	2.5
11	Beriti Kora	"	27	-	1	-	-	1	2.5
12	Simbiro	"	15	-	1	-	-	1	2.5
13	Chebiha	"	23	-	-	-	1	1	2.5
14	Tatesa Batu	Ziway-Dugda	77	-	-	-	1	1	2.5
15	Kechema Shuka	Tiyo	40	-	-	-	1	1	2.5
16	Bosha	"	9	-	-	1	-	1	2.5
Total				4	11	1	24	40	100
Percent				10.0	27.5	2.5	60.0	100	

Source: Field Survey of Charcoal Suppliers, February, 2000.

5.5.2 Source of Origin of Fuelwood

Unlike the source of charcoal supply the fuelwood flows to the town from all directions in varied quantities (Fig. 14). And all the sample suppliers are from Peasant Associations of Tiyo wereda and Asella town (Table 33).

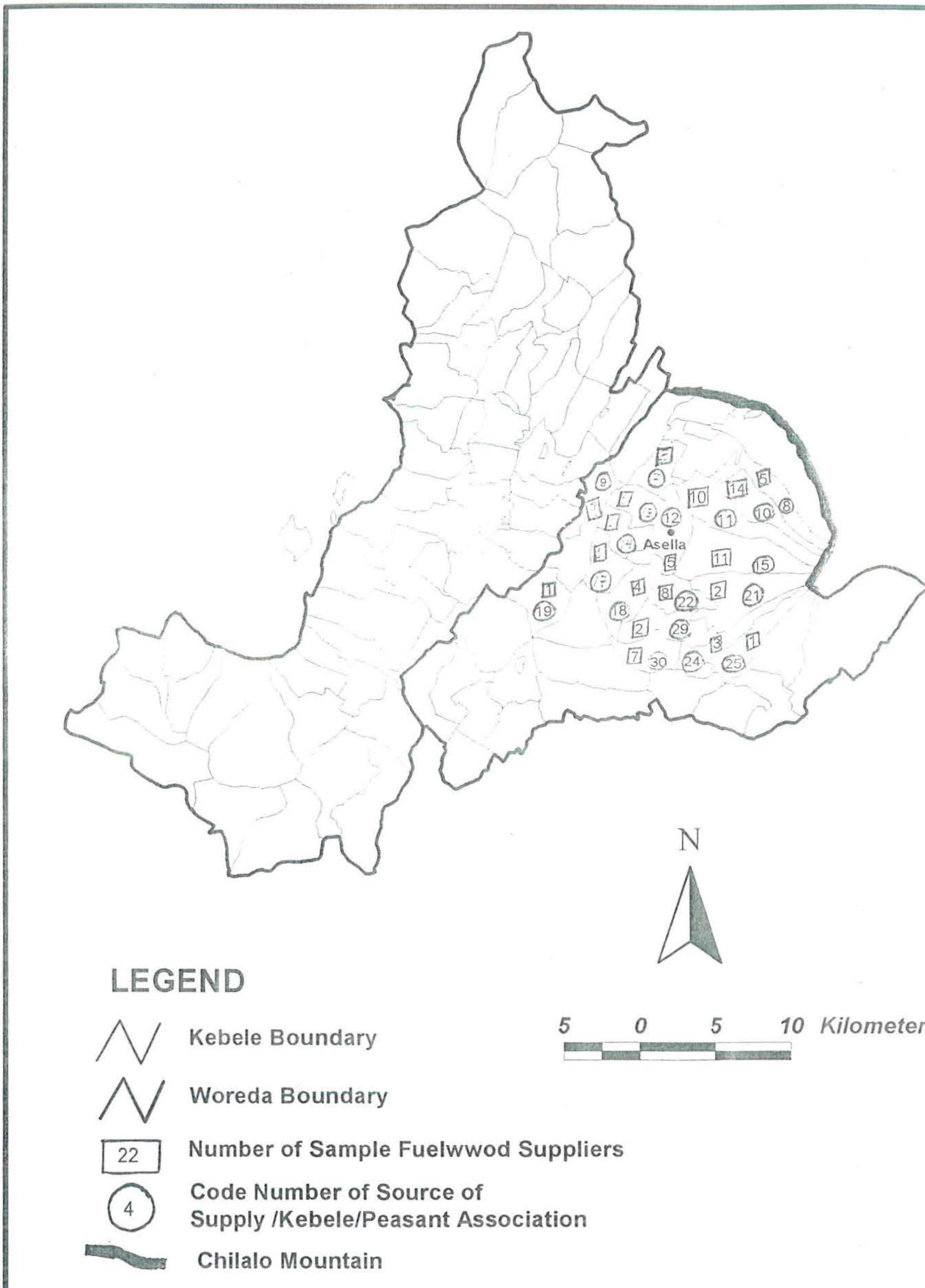
For analysis of the sources of origin of supply of fuelwood from outside Asella town, the Peasant Associations can be grouped into four based on directions i.e., from East, South, North and West.

As it is evident from Fig.14 that four Peasant Associations Denekaka Beriecha, Simbiro, Koniha kae and Akeya Lokecha found a Eastern side of Asella town on the Western Slopes of Chilalo Mt. dominate in the origin of source of supply generating 40(50%) out of 80 fuelwood suppliers, each one of these sources accounts 14(17.5%), 11 (13.75%), 10(12.5%) and 5 (6.25%) of fuelwood suppliers respectively. These peasant associations are rich in forest resources to this extent Kebrom (1984: p.2) in his study "Altitudinal plant Zonation on the western slope of Mount chilalo: Arsi" indicates the significants of Chilalo Mt. as a source of fuelwood supply for Asella as:

> "The Chilalo Mountain, important for timber resource and ... Moreover, it is not unusual to see people cutting down big trees for fuel to be sold at Asella, the near by town".

From South 21(26.75%) of the total suppliers inter the town. Thus, Dosha, Bilalo, Duna and Ealena Peasant Associations accounts 8(10.0%), 7(8.75%), 4(5.0%) and 2(2.5%) of the total sample suppliers respectively.

Fig. 14 NUMBER OF FUELWOOD SUPPLIERS BY KEBELES/PEAS ASSOCIATIONS



Source: Field Survey, Feb. 2000.

From South-eastern side of the town the source of supply of fuelwood is from three Peasant Associations namely, Aleltu Shala, Kula and Beriti Shala contributing 3(3.7 5), 2(2.5%) and 1(1.25%) of the total as a source of origin of suppliers respectively. Only 8 sample suppliers brought fuelwood from North, West and South West from six Peasant Associations namely: Bosha, Selingo Dara, Lalo Choka, Tulu Dimtu, Dugda Michael and Tulu Kuehie which accounts 2.5%, 2.5%, 1.25%, 1.25%, 1.25% and 1.25% of the total suppliers respectively (Table 33 and Fig 14).

Asella towns also serve as a source of fuelwood supply of its inhabitants. Thus, five sample suppliers from kebele 11, 12 and 13 which accounts 6.25% of the total suppliers respond that they brought the fuelwood from respective kebeles in which they live in.

Table 33: Source of Supply of Fuelwood and Means of Transport Used

No	Source of Supply	Wereda	Code No. on Fig. 20	Means of Transport					Total	%
				Child	Women	Men	Donkey	Horse		
1	Denkaka Beriecha	Tiyo	10	-	1	5	8	-	14	17.50
2	Simbiro	"	15	2	1	2	6	-	11	13.75
3	Konicha Kae	"	11	-	2	1	7	-	10	12.50
4	Akeya Lokecha	"	8	1	1	3	-	-	5	6.25
5	Dosha	"	22	-	4	-	4	-	8	10.0
6	Bilalo	"	30	-	2	-	4	1	7	8.75
7	Duna	"	18	1	-	-	3	-	4	5.00
8	Ealena	"	29	-	-	-	2	-	2	2.50
9	Aletu Shala	"	24	-	-	-	3	-	3	3.75
10	Kula	"	21	-	-	-	2	-	2	2.50
11	Beriti Shala	"	25	-	-	-	1	-	1	1.25
12	Bosha	"	9	-	-	-	2	-	2	2.50
13	Selinego Dora	"	7	-	1	-	1	-	2	2.50
14	Lalo Choka	"	13	1	-	-	-	-	1	1.25
15	Tulu Dimtu	"	14	-	-	-	1	-	1	1.25
16	Dugda Michael	"	19	-	-	-	1	-	1	1.25
17	Tulu Kuchie	"	17	-	-	-	1	-	1	1.25
18	Asella	"	12	1	1	-	3	-	5	6.25
Total				6	13	11	49	1	80	100
Percent				7.50	16.25	13.75	61.25	1.25	100	

Source: Samply Survey of Fuelwood Suppliers, February, 2000.

5.6 Types of Tree Species Supplied as Woodfuel

No single type of tree species was supplied as a source of charcoal and fuelwood though there were few tree species supplied for both purposes.

The reporting by the suppliers conveying the tree species used as a source of charcoal and fuelwood indicated more diversified species are used for latter, because some of tree species produce more ash during charcoal making process and have low thermal efficiency as charcoal furthermore, approachability of the source of supply and availability of tree stands are the other factors which determine the supply of tree species as fuelwood, charcoal or both.

5.6.1 Tree Species Used for Charcoal

Out of 40 sample charcoal suppliers, 28(70.0%) reported mainly two species: Acacia and Erica Arborea which accounts 19(47.5%) and 9(22.5%) respectively.

Only 10% and 5% of sample respondents from amongst the charcoal suppliers reported Rapanea simensis and Dombeya goetzenii species for making charcoal.

Galiniera coffeoides , Olinia usambarensis, Rhus natalensis and pygeum africanum tree species were reported as a source of charcoal by 2.5% each.

Two suppliers, i.e., 5% were not able to identify the tree species used for making charcoal (Table 34).

Table 34: Tree Species Supplied as a Source of Charcoal by Sample Suppliers

No	Types of Tree Species	Local Name	No	(%)
1	Acacia	Dare, Girare, Lafto	19	47.5
2	Drica arborera	Asta, Sato	9	22.5
3	Rapanea Simensis	Tula	4	10.0
4	Dombeya goetzenii	Makanisa	2	5.0
5	Galiniera coffeoides	Mito	1	2.5
6	Olinia Usamberensis	Ashakamo	1	2.5
7	Rhus natalensis	Tatesa, Mitsti aybelash	1	2.5
8	Pygenum africanum	Tikur inchet, Gerbi	1	2.5
9	Unidenfiied tree species	-	2	5.0
Total		-	40	100

Source: Sample Survey of Charcoal Suppliers, February, 2000.

5.6.2 Tree Species Used for Fuelwood

According to the response of sample supplies, the types of tree species supplied as fuelwood are varied such as eucalyptus, erica arborea, hagenia abyssinica, acacia, juniporus procera, podocarpus gracilior, hypericum revolutun etc. (Table 35). However, out of 80 sample suppliers 61(76.2%), 16(20.0%) and 3(3.8%) supplied a single species, a mixture of two species and a mixture of three species respectively (Table 35).

Among the suppliers of a single tree species for fuelwood 38 supplied eucalyptus while erica arborea, hagenia abyssinica, acacia, junipersous procera and podocarpus gracilior by 14, 4, 2, 2 and 1 suppliers respectively. (Table 35).

Of all tree species supplied as a mixture of two species hagenia abyssinica and hypericum revolutun are the dominant one. Only one out of 16 suppliers had a mixture without hagenia abyssinica and hypericum revolutun.

Hagenia abyssinica also constitute a specie in the combination of three species in the fuelwood of the 3 sample suppliers in the category (Table 35).

In general, the dominant tree species used for fuelwood are eucalyptus and erica arborea. Other dominant specie include hagenia abyssinica and hypericum revolutun are mostly supplied as a mixed fuelwood from other tree species .

Table 35: Tree Species Supplied as a Source of Fuelwood by Sample Suppliers

No	Types of Tree Species	Local Name	No	%
Supplied as a Single Species				
1	Eucalyptus	Bahir Zaf	38	47.5
2	Erica arborea	Asta/Sato	14	17.5
3	Hagenia abyssinica	Koso/	4	3.75
4	Acacia	Lafto/Girare	2	2.50
5	Juniperus procera	Tid/Gatira	2	2.50
6	Podocarpus gracilior	Zigba/Birbirsa	1	1.25
Supplied as a Mixture of Two Species				
7	Hagenia abyssinica and Podocarpus gracilior	Koso(heto) and Zigba (birbirsa)	3	3.75
8	Hagenia abyssinica and Hypericum revolutun	Koso (heto) and Amija	2	2.50
9	Hagenia abyssinica and Erica arborea	Koso(heto) and Asta(Sato)	1	1.25
10	Hagenia abyssinica and Schefflera volkensis	Koso(heto) and Ansha	1	1.25
11	Hagenia abyssinica and Rapanea simensii	Koso(heto) and Tula	2	1.25
12	Hagenia abyssinica and Juniperous procera	Koso(heto) and Tid(Gatira)	1	1.25
13	Hypericum revolutun and Schefflera volkensii	Amija and Ansha	2	2.50
14	Hypericum revolutun and Raganea simensis	Amija and Tula	1	1.25
15	Hypericum revolutun and Erica arborea	Amija and Asta(Sato)	2	1.25
16	Juniperus procera and Podacarpus gracilior	Tid(Gatira) and Zigba (Birbirsa)	1	1.25
Supplied as a Mixture of Three Species				
17	Hagenia abyssinica, Junipierus procera and Podocarpas grocilior	Koso(heto), Tid (Gatira) and Zigba (Birbirsa)	1	1.25
18	Hagenia abyssinica, Juniperous procera and Schefflera volkensii	Koso (heto), Tid (Gatira) and Ansha	1	1.25
19	Hagenia abyssinica, Schefflera volkensis and Hypericum revolutun	Koso(heto), Ansha and Amija	1	1.25
Total			80	100

Source: Sample Survey of Fuelwood Suppliers, February, 2000.

5.7 Travel Distance and Woodfuel Supplly

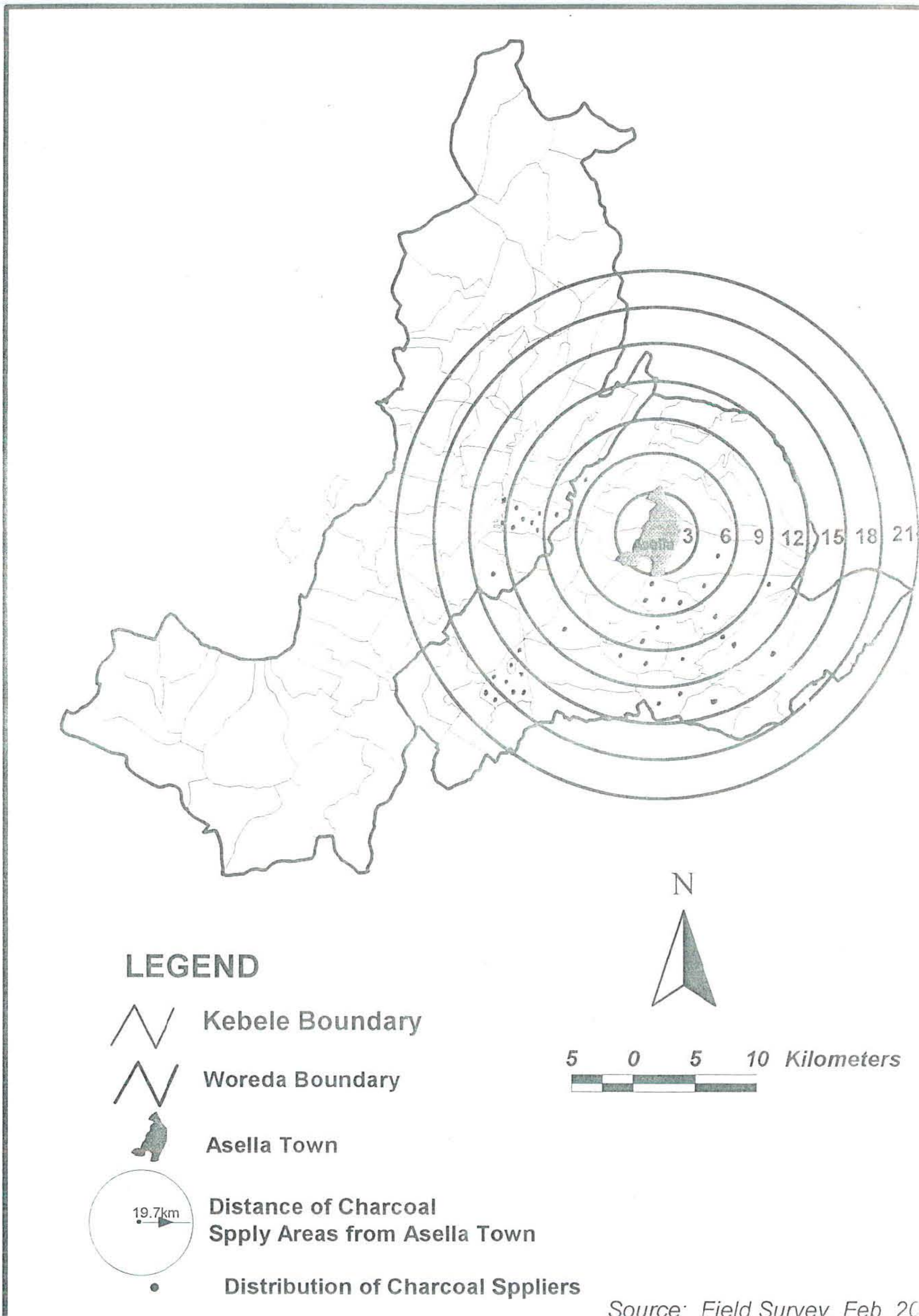
The studies on travel distance of woodfuel suppliers in general and fuelwood in particular, in Ethiopia indicate variations. Among them the two worth mentioning are, the study made by CESEN (1984: p.30) which shows that in certain areas suppliers traveled upto 20 km and over inorder to collect a donkey load of fuelwood and the study made by Fikereta (1995: p.3) which found that the bulk of fuelwood supply for Addis Ababa is met from forests located with in a radius of 100 kms around the city. This indicates not only the process of deforestation around urban settlements but also its effect on distant areas. It is very likely that the travel distance will increases with the size of urban centers.

5.7.1 Distance – Woodfuel Supply Relationship of Asella Town

The data on charcoal and fuelwood suppliers indicate that they are supplied from sources located at different distances i.e.; in a radius of 19.7 km and 12.2 km respectively from the center of the town (Fig. 15 and Fig. 16). The greater distances of supply of charcoal can be attributed to lesser weight and easy of transport. Bundles of fuelwood are bulky and irregular hence are seldom profitable to transport it over longer distance.

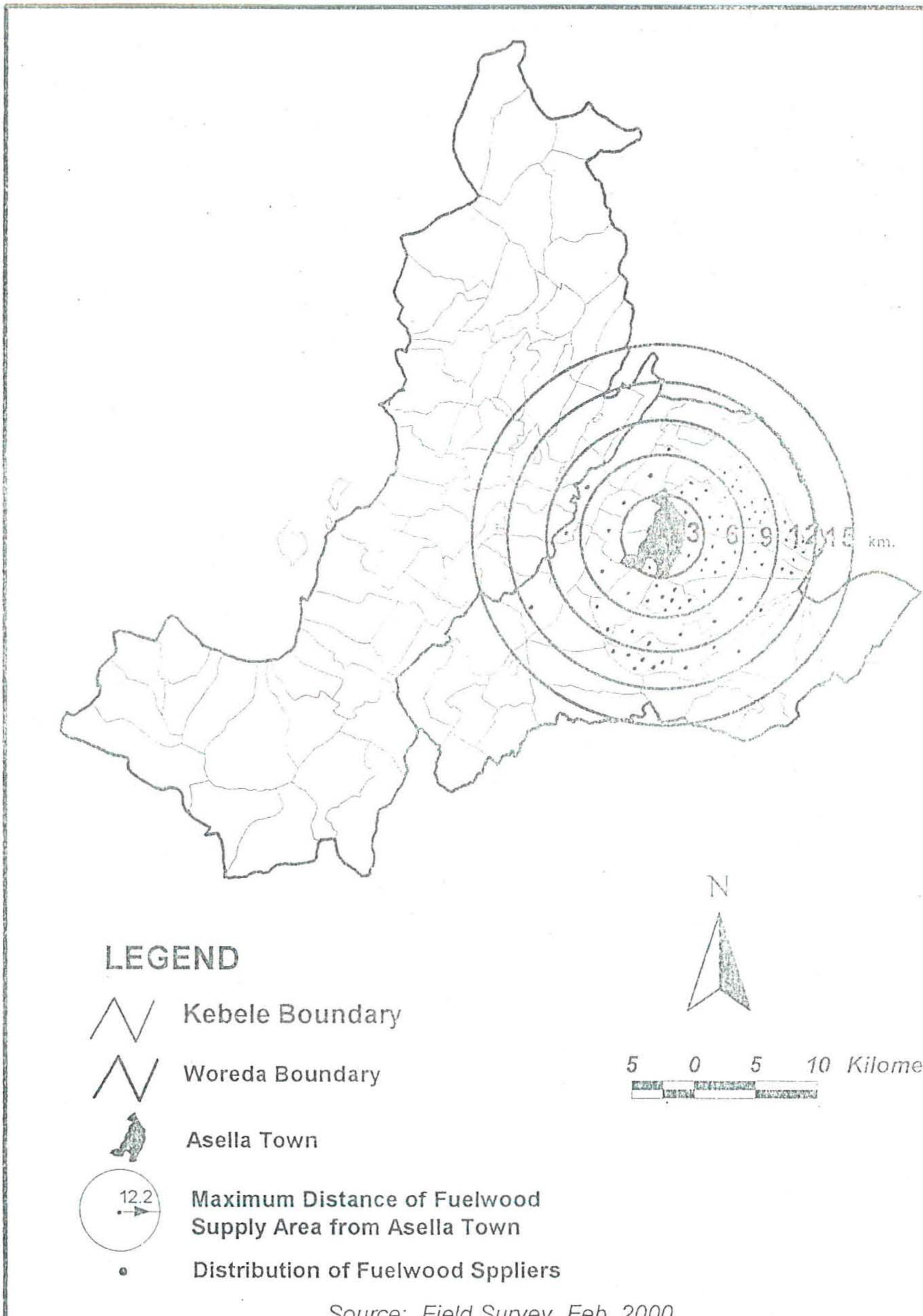
The effect of distance on supply of charcoal and fuelwood can also be explained by correlating the distance traveled by suppliers from source of

Fig. 15 DISTRIBUTION OF CHARCOAL SUPPLIERS OVER SUPPLY SOURCCE, AREA AND DISTANCE FROM ASELLA TOWN



Source: Field Survey, Feb. 20

Fig. 16 DISTRIBUTION OF FUELWOOD SUPPLIERS OVER SUPPLY SOURCCE, AREA AND DISTANCE FROM ASELLA TOWN



Source: Field Survey, Feb. 2000.

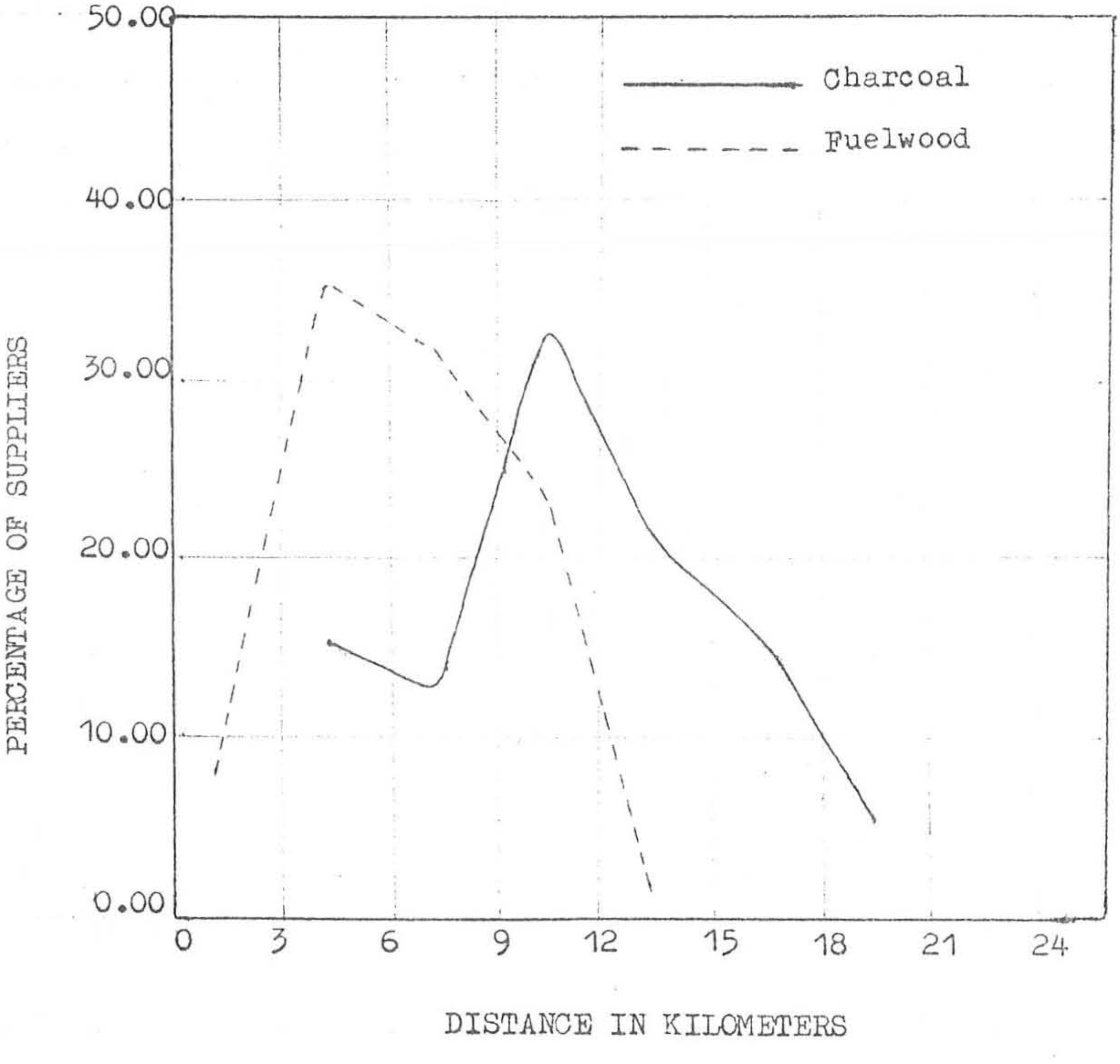
supply to the center of the town and the percentage of suppliers in relation to distance.

The graph of distance – woodfuel supply relationship shows, the largest percentage (60% and 75%) of charcoal and fuelwood suppliers are traveling 9-12 km and 6-9 km respectively from the source to the center of the town (Fig. 17). The observation from Fig. 17 also indicates that the expected distance – decay concept is not holding good in either of the cases. The lesser proportion of suppliers from near by may be due to the non existence of the wood lands near the town. It is also revealed that the decline in the proportion of the suppliers on either sides from the zone of maximum suppliers in both the cases.

In general, though almost the whole area of the town is to be found within 3km radius from the center of the town (Fig. 15 and Fig 16) the close rural hinterlands of Asella town are not the largest supplier of charcoal and fuelwood. Thus, only 11 (27.5%) and 35 (43.75%) of charcoal and fuelwood sample suppliers traveled up to 9 km and 6 km respectively. This probably indicates because of its growing population over time the town experienced depleting wood sources and wood is no longer so plentiful that can be easily collected from the town and its vicinity. Therefore, suppliers had begun travelling farther and farther to the areas of rich wood resources.

The combine effect of deforestation, scarcity, longer travel distance and the general inflation is reflected in rise of prices of woodfuel over time. For example retail price of fuelwood averaged to Birr 22.26/m^3 in 1987 which rose to Birr 72.54/ m^3 in 1998 (SSA, 1988, 1998).

Fig.17 Distance - Woodfuel Supply Relationship
for Asella Town



Source : Field Survey, Jan. 2000

5.8 Duration of Involvement in Supply Activity and Frequency of Supply

5.8.1 Duration of Involvement

The investigation concerning duration of involvement of suppliers in activity, out of 120 suppliers questioned, more than half (52.5%) are engaged in the business since 3 years or less. When examined separately for charcoal and fuelwood the proportion are 60% and 48.75% respectively. Those engaged in the activity since greater than 5 years about only 7.5% and 11.25% respectively (Table 36). This pattern clearly points towards conclusion that the activity is mostly adopted temporarily by the people, till they are engaged in some other permanent activities.

Table 36: Duration of Involvement in Supply Activity of Charcoal and Fuelwood

Duration	Charcoal		Fuelwood		Total	%
	No	%	No	%		
Less than 1 year	5	12.5	8	10.00	13	10.8
1 –2 years	8	20.0	15	18.75	23	19.2
2 – 3 years	11	27.5	16	20.00	27	22.5
3 – 4 years	9	22.5	19	23.75	28	23.3
4 – 5 years	4	10.0	13	16.25	17	14.2
More than 5 years	3	7.5	9	11.25	12	10.0
Total	40	100	80	100	120	100

Source: Sample Survey of Charcoal and Fuelwood Suppliers, February, 2000.

5.8.2 Frequency of Supply

The frequency of supply of charcoal and fuelwood by sample suppliers shows, that the supply of fuelwood is relatively more frequent than charcoal. Even non of the sample suppliers of charcoal confirmed daily supply. Where as out of 80 sample fuelwood suppliers 7(8.8%) rated that they supplied daily. This is because of the either processes of making charcoal or the purchasing, from other markets both of which need sometimes while collection of wood can be done much faster.

The first and the second frequency of supply rated by both charcoal and fuelwood suppliers are supply once in a week and twice in a week, Thus, 15(37.5%) and 21(26.3%) of charcoal and fuelwood suppliers rated that they supply once in a week, where as suppliers rated twice in a week account for 12(30.0%) and 18(22.5%) respectively (Table 41).

Table 37: Frequency of Supply of Charcoal and Fuelwood

Frequency of Supply	Charcoal		Fuelwood		Total	%
	No	%	No	%		
Daily	-	-	7	8.8	7	5.8
Three times in a week	1	2.5	9	11.3	10	8.3
Twice in a week	12	30.0	18	22.5	30	25.0
Once in a week	15	37.5	21	26.3	36	30.0
Once in two weeks	5	12.5	11	13.8	16	13.3
Once in a month	7	17.5	10	12.5	17	14.2
Non regular suppliers (occasional or irregular)	-	-	4	5.0	4	3.4
Total	40	100	80	100	120	100

Source: Sample Survey of Charcoal and Fuelwood Suppliers, February 2000.

Occasional or irregular suppliers accounts 4(5.0%) of the total fuelwood suppliers, and frequency of supply three times in a week accounts 1(2.5%) and 9(11.3%) of the total charcoal and fuelwood suppliers respectively.

The overall frequency supply distribution indicates that about 70% of 120 sample suppliers supply at least once in a week. An average about 25% and 16.25% of sample fuelwood and charcoal suppliers made daily trips to the town.

5.9 Seasonal price of Woodfuel

Sample suppliers of woodfuel (charcoal and fuelwood) were asked about the price of charcoal and fuelwood during summer season (June, July and August, 1999) and winter season (Dec., 1999, Jan., and Feb., 2000). Invariably the concerned suppliers approved the higher prices during winter in case of charcoal (87.5%), fuelwood (82.5%) and over all (84.2%). It is strange that 10% of fuelwood suppliers did not accept the price differences (Table 38).

Table 38: Seasonal Price of Charcoal and Fuelwood

Seasonal	Charcoal				Fuelwood				Total			
Price	Sum.	%	Win.	%	Sum.	%	Win.	%	Sum.	%	Win.	%
Higher	1	2.5	35	87.5	-	-	66	82.5	1	0.80	101	84.20
Lower	35	87.5	1	2.5	66	82.5	-	-	101	84.20	1	0.80
No Price Difference	-	-	-	-	8	10.0	8	10.0	8	6.67	8	6.67
No Response	4	10.0	4	10.0	6	7.5	6	7.5	10	8.33	10	8.33
Total	40	100		100	80	100	80	100	120	100	120	100

Source: Sample Survey of Charcoal and Fuelwood Suppliers, February, 2000

5.9.1 Reasons for Lower Price of Charcoal and Fuelwood in Summer Season

From different alternatives given, for price variation between the two seasons, only two reasons i.e., better supply condition and dry climate and seasonal shortage of food either exclusively or together, were expressed by suppliers (Table 39).

Table 39: Reasons for Lower Price of Charcoal and Fuelwood

No	Reasons for Lower Price	Charcoal		Fuelwood		Total	%
		No	%	No	%		
1	Low demand of consumers	-	-	-	-	-	-
2	Accessibility and no supply shortage	-	-	-	-	-	-
3	Climatic conditions	-	-	5	6.25	5	4.17
4	Prevailing food shortage	18	45.0	41	51.25	59	49.17
5	Climatic condition and shortage of food	16	40.0	20	25.00	36	30.00
6	No response	4	10.0	6	7.50	10	8.30
7	No price variation	-		8	10.00	8	6.67
8	Others	2	5.0	-	-	2	1.66
	Total	40	100	80	100	120	100

Source: Sample Survey of Charcoal and Fuelwood Suppliers, February, 2000

It is also note worthy that climate alone was not given as a reason by charcoal suppliers. Thus, the major reasons for low price in summer season were food shortage and food shortage along the climate were given the reasons by 45% and 40% of respondents from charcoal suppliers respectively. In case of fuelwood suppliers 6.25% of the respondents expressed climate exclusively as the reason while 51.25% expressed food shortage and 25.00% food shortage along with climates respectively as the reason (Table 39) for lower prices during summer season. This pattern indicates the "sale under duress" situation. Hence, if the supplier are the food scarcity for the summer season, they might not be under pressure to sale their good at lower prices.

Among the climatic conditions, the failure of rainfall during spring season (March, April, May, 1999) affected adversely the growing belg crops in general. Therefore; the prevailing subsistence agriculture which was not supported by belg crops of 1999 contributed a lot to the shortage of food. The shortage of food, on the other hand, also forced the rural people to supply charcoal and fuelwood more than the market demand which resulted in lower prices in summer season of 1999.

5.9.2 Reasons for Higher Price of Charcoal and Fuelwood in Winter Season

Shortage of supply due to other means of livelihood and the involvement of suppliers in harvesting activities are the two reasons that contribute to higher price of charcoal and fuelwood in winter season (Dec., 1999, Jan., and Feb., 2000). From sample charcoal and fuelwood suppliers 31(77.5%) and 47(58.75%) respectively responded in favour price in winter season was higher because of supply shortage, hence, the suppliers have other means of generating livelihood, for example, farmers woodfuel suppliers can sale crops to have an income (cash) and to buy other required goods. The other reason given by 2(5.0%) and 19(23.75%) of charcoal and fuelwood suppliers is supply shortage due to involvement of suppliers in harvesting activity (Table 40).

Table 40: Reasons for Higher Price of Charcoal and Fuelwood

No	Reasons for Higher Price	Charcoal		Fuelwood		Total	%
		No	%	No	%		
1	Supply shortage because of other means of livelihood of suppliers	31	77.5	47	58.75	78	65.0
2	Supply shortage because of involvement of supplier in harvesting activity	2	5.0	19	23.75	21	17.5
3	No price variation	-	-	8	10.0	8	6.7
4	No response	4	10.0	6	7.5	10	8.3
5	Others	3	7.5	-	-	3	2.5
	Total	40	100	80	100	120	100

Source: Sample Survey of Charcoal and Fuelwood Suppliers, February, 2000.

In general, according to the respondents, when charcoal and fuelwood price considered together 99(82.5%) of both charcoal and fuelwood suppliers reasoned higher price in winter season was attributed to supply shortage due to involvement of suppliers in harvesting activities and other means of generating livelihood.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSIONS

Energy is the source of life and the basis for all sort of economic activities and development. From the beginning of humans civilization until early in the 19th century most of the energy needs were met by biomass sources, mainly wood. It has gradually been replaced by other major fuel sources in developed countries, but many developing countries like Ethiopia still rely heavily on it as source of fuel. Therefore, the amount and form of energy that different societies consume can be taken as an indicator of the degree of development attained.

The study on household energy consumption and supply pattern in Asella town reveals the following:

I. Regarding household energy consumption:

1. Multiple sources of energy are commonly used by individual sample households for day-to-day household energy requirements which include biamass sources (fuelwood, charcoal, BLT and saw dust) and modern soruces (electricity and kerosene).
2. Expenditure on various types of household energy varies among different households depending upon the economic status. Thus, Average monthly expenditure varies from Birr 12.85/household to Birr 102.87/household and per

capita average monthly expenditure varies from Birr 1.96/pers to Birr 16.46/pers for very low and very high income groups respectively.

3. From multiple correlation coefficient it was observed that total expenditure on all types of household energy positively correlated (+0.6205) with household size and household monthly income. However, the degree of correlation differs significantly when household size and household income are considered separately i.e., +0.3156 with the former and +0.6010 with the latter.

Multiple correlation between dependent variables i.e., (expenditure on fuelwood, charcoal, electricity and kerosene) and independent variables (household size and household income) was +0.4588, +0.6167, +0.5913 and +0.5702 respectively. Significant variation, however, exist in coefficient of correlation between expenditures on the four components of energy sources separately with households income as household produces coefficients as +0.352, +0.320, +0.217 and +0.255 with fuelwood, charcoal, electricity, and kerosene respectively which the respective coefficient with household income are +0.381, +0.525, +0.588 and +0.560. Thus, it can be concluded that expenditure on various types of household fuels is better correlated with the income of households than household size.

4. With increasing household income there is a decline in expenditure on household energy as percent of income. Thus, it is 21.82 % of monthly income for very low income group while it is only 7.31% of the monthly income of very high income group
5. Out of the total expenditure if the sample households on household energy it is found that 61.39% is spent on traditional biomass fuel (fuelwood 31.23%, charcoal

26.96%, BLT and Saw dust 3.20%) and 38.61% on modern fuels (electricity 22.03% and kerosene 16.58%). Furthermore, expenditures on traditional fuels decline with increasing household income while it increases on modern fuels.

6. Household energy consumption interms of heat value varies significantly between various fuel types. Traditional biomass fuels are dominantly consumed which accounts for 86.32% (fuelwood 57.33%, charcoal 21.30%, and BLT & saw dust 7.69%). The consumption of modern fuels accounts only 13.68% (5.97% electricity and 7.71% kerosene). Generally, the overall consumption of household fuels indicates there is a tendency to shift from traditional to modern fuels with increasing household income.
7. With rise in household income there is an increase in total amount of energy consumed per households interms of heat value from 650.11 MJ for very low income group to 3368.41 MJ for very high income groups. Similarly, per capita consumption of various energy also increase from 99.41 MJ for very low income group to 777.92 MJ for very high income group.
8. Per capita consumption also varies between fuel types. Thus, it is found that average per capita consumption of traditional fuels (fuelwood, charcoal, BLT and saw dust) for the whole of sample population was 24.26 kg/pers/month, but it was only 5.89/pers/month for very low income group and 43/75kg/pers/month for high income group. For very high income group it is 34.48 kg/pers/month due to the shift to modern fuels (electricity).

Per capital consumption of electricity for the whole of sample population was 6.76 kwh/pers/month, which ranged from 1.65 kwh/per/month for very low income groups to 19.93/ kwh/per/month for very high income groups.

Per capital consumption of kerosene also varies significantly with income. Thus, it was 0.23 liter/pers/month for very low income group and 2.29 liter/pers/month for high income group. But very high income groups consumed less per capita (1.88 liter/pers/month) as compared to high income group due to the shift to electricity.

I. Regarding household energy supply

1. The types of biomass fuels supplied are fuelwood, charcoal, BLT, tree roots and dung. And the means of transport used to supply are human labour (women, men and child) and pack animals (donkey and horse).

   Donkey loaded suppliers of fuelwood and charcoal dominate in overall quantity of supply which varies significantly between market and non-market days.

   Human labour was the most important means of transport used in supplying BLT where child labour dominated followed by womens and men. As to the market and non market days, the supply of BLT showed insignificant variation.

Dung was the least supplied biomass fuel and it was mainly supplied by children followed by women. Human carriers also dominated in supply of tree roots i.e., women accounted for the largest group followed by childrens and men. Agri-residues were also supplied in large quantity mainly by donkeys but its significance for household fuel is almost nil in Asella town.

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2. The amount of energy inflow from charcoal and fuelwood by human and animal carriers was about 130,993.87 MJ/day and 372,221.09 MJ/day respectively.

3. It was also found that more than 60% of charcoal and fuelwood suppliers were in the age group of 10-29 and more than 85% of the suppliers of woodfuel were from outside Asella town. More than 50% of charcoal and fuelwood suppliers were illiterate.

4. Beside for peoples directly engaged in supply of fuelwood and charcoal as their permanent occupation, it was also practiced as secondary occupation to supplement their earnings by formers, housewives, students and people without permanent occupation.

5. Different methods were used by suppliers to obtain and supply fuelwood and charcoal. Thus, 50% of charcoal suppliers bought charcoal for re-sale in Asella town and 42.5% prepared charcoal by collecting, cutting and collecting and cutting wood from wood lands. More than 60% of fuelwood suppliers obtained fuelwood to supply the town by cutting, collecting and cutting and collecting wood from wood lands. About 23.75% used their own trees and 12.50% purchased the trees for supplying as fuelwood.

6. The source of origin of charcoal was mainly peasant associations and small villages of Tiyo and Ziway Dugda weredas accounting respecively for 75 and 25% of sample suppliers of charcoal.

The origin of fuelwood supply was completely from peasant Association of Tiyo wereda and three kebeles of Asella town. Generally Easterns ide of Asella town and the Western slope of Chilalo mountain accounted for 50% of source of origin of sample fuelwood suppliers.

7. Acacia and erica arborea are the dominant tree species used for making charcoal. Eucalyptus, eraca arborea, hagenia abyssinica and hypericum revolutun tree species are used for fuelwood.

8. Distance and woodfuel supply relationships indicate that charcoal was supplied even from greater distances up to (19.7km) than fuelwood (12.2 km). Only 27.5% and 43.75% of charcoal and fuelwood suppliers traveled distance up to 9 km and 6 km respectively which probably indicates deforestation in and in areas surrounding Asella town.

9. It is found that there was price variation between summer season (June, July and winter season (Dec., 1999, January and February 2000). And the price was higher in winter season than summer. The major reasons for low price were food shortage and prolonged dry condition (the in of rainfall during spring season of 1999). Thus, the prevailing subsistence agriculture which was not supported by belg crop of 1999 contributed a lot to shortage of food which also forced the rural people to supply woodfuel more than the market demand.

On the other hand, shortage of supply due to other means of livelihood and the involvement of suppliers in harvesting activities are the two reasons that contributes to high price of woodfuel in winter season.

6.2 RECOMMENDATIONS

Household energy demand is mostly met by woodfuel which is mainly supplied from rural areas. If the present woodfuel consumption rate is allowed to continue, it will lead to an agro - ecological crisis and urbanand rural poors would have to face the consequences of their continued dependence on woodfuel. Particularly urban poors spend the largest share of their income on Household energy where the major component is the woodfuel energy supply. Therefore, to over come the problem, the following solutions would be recommended:

1. In identifying the extent of wood shortage, natural forest and tree resource inventory is the primary tool for energy planning. Therefore, the concerned government and non-government organizations should have to under take detailed study on wood balance so that woodfuel demand-supply balance can be determined.

2. To solve household energy problems in general, and woodfuel in particular, expansion of woodfuel resource through afforestation and pre-urban forestry program need be undertaken. To achieve this fast growing tree species should be ifentified according to climatic condition of the area and introduced in the programmes.

3. Creating environmental awareness among the communities and encouraging people to plant more trees on land not suitable for crop production through free supply of tree species can be encouraged.

4. Exploitation of the investigated hydro carbons (natural gas and oilshale) at different localities of the country should be given priority so that it can be available for household use at low prices as well as it will reduce the pressure on the existing wood resources.

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APPENDIX 1

Questionnaire for Household Energy Survey in Assela Town (1982 E.C.)

A. Enumerator's Name ________________

B. Date of Interview ________ month _________

Sample Identification

1. Kebele __________ 2. House No. ___________

3. Name of Head of Household ______________________

Part I. Household Size, and Household Income

1. Total number of people in the household _________

   1.1 Adults above 15 years

   Males _________ Females _________

   1.2 Children's below 15 years

   Males ________ Females _________

2. Household Income Per month

   A. Household Income _________ B. Wife Income _________

   C. Income from other source _____________

Part II. Household Energy Sources and Consumption

2.1 Modern Sources of Energy

2.1.1 Electricity

3. Is your residential house provided with electric supply?

   A. Yes B. No

   * If your answer for question No. 12 is no, answer question no. 4 and 5.

4. What is/are the reason(s) for not having electric supply?

A. Your residential house is newly constructed

B. You don't have enough money

C. You ask EELPC, by paying the necessary fee, and you are on waiting list

D. Other specify ________________

5. What do you use for lighting?

A. Wood	E. Wax
B. Kuraz	F. Leaves
C. Lamp	G. Battery
D. Candle	H. Other specify ____________

If your answer for question No. 12 is yes, answer the following questions 6 to 14.

6. The Kilowat hour meter serves:
   A. Only for own family
   B. Shared with other households

7. If the Kilowat hour meter is shared with other household, how many households are served by it? ________________

8. Do you use electric light for your toilet room?

   A. Yes   B. No

9. If your answer for question No. 17 is no, what do you use for lighting?

A. Kuraz	C. Candle	E. Match & Paper
B. Lamp	D. Battery	F. Other specify ___________

10. Do you use electric light for kitchen room?
    A. Yes   B. No

11. If your answer for question No. 19 is no, what do you use for lighting?

A. Kuraz	C. Candle	E. Leaves
B. Lamp	D. Wood	F. Other specify _________

12. The family use electricity for what purpose?
    A. Lighting   F. Refrigerator

B. Baking "injera"
C. Television
D. Taperecorder
E. Radio
G. Boiler
H. Ironing
I. Electric stove
J. Other specify __________

13. Before the family started to use electricity for baking "injera", cooking and heating wat and other food, making tea and coffee and boiling water which of the following sources were used?
    A. Fire wood
    B. Charcoal
    C. Firewood & Charcoal
    C. Other specify ____________
    D. Kerosine
    E. Diesel oil
    F. Always the family used electricity

14. What was your monthly expenditure on electricity the months of January 2000?

    Expenditure for January, 2000 ___________

2.1.2 <u>Kerosene</u>

15. Does the family uses kerosine?

    A. for lighting
    B. for cooking and heating food
    C. for making tea and coffee
    D. for boiling water
    E. for burning charcoal
    F. other specify _____________________

16. From where did the family buy kerosine?
    A. From petrol station
    B. From petroleum product retailers
    C. From kerosine retailers
    D. Other specify ____________________

17. How many litters of kerosine was consumed by the family during the months of January, 2000?

    January, 2000 _______ liter(s)

18. What was the expenditure for kerosine consumed for the month and year indicated above?

Expenditure for January, 2000 ___________

19. Before the family started using kerosine, which of the following sources were used?

A. Fire wood
B. Charcoal
C. Firewood & Charcoal
D. Diesel oil
E. Electricity
F. The family uses kerosine always
G. Other specify __________

2.2 Traditional Sources of Energy

2.2.1 Fire wood

20. Does the family uses firewood?

A. Yes B. No

21. How does the family obtain fire wood for consumption.

A. Always through purchasing
B. Through collecting
C. Through purchasing and collecting
D. By cutting own stand tree
E. Through gift
F. Other specify ___________________

22. If the family obtain fire wood, for consumption, always through purchasing, from where did the family purchased firewood for the month of January, 2000?

A. From donkey loaded suppliers
B. From women firewood carriers
C. From men firewood carriers
D. From children firewood carriers
E. Other specify ___________________

23. During the month of January, 2000, what was the families total expenditure on fire wood?

Expenditure for January, 2000 ____________

24. Is the family faced high priced and scarcity of fire wood since started to live in Asella town?

A. Yes B. No

25. If yes, how does the family cope with high priced and scarcity of fire wood?

A. Do nothing
B. Substitute with other source(s) of energy
C. Buy ready made food
D. Cooking one meal for lunch and dinner instead of cooking two meals in a day
E. Store fire wood, at a time of low price, through buying
F. Other specify ____________________

26. If the family substitute with other source(s) of energy & to cope with high priced and scarcity of firewood, which of the following sources were used as a substitute?

A. Dung
B. Saw-dust
C. BLT (Branches, Leacves and Twigs)
D. Tree roots
E. Agri-residues
F. Kerosine
G. Electricity
H. If other specify ____________________

2.2.2 Charcoal

27. Does the family uses charcoal?

A. Yes B. No

28. How did the family obtain charcoal for consumption?

A. From utilized (used) fire wood at home
B. Through purchasing
C. From utilized fire wood at home and through purchasing

D. Other specify ______________________

29. If the family obtain charcoal, for consumption, through purchasing, from where did the family purchased charcoal for the month January, 2000?

A. From charcoal retailers at shop and street
B. From charcoal retailers at market
C. From whole sellers at market
D. Other specify ____________________

30. During the month of January, 2000 what was the families total expenditure on charcoal?

Expenditure for January, 2000 __________

31. Is the family faced high priced and scarcity of charcoal since started to live in Asella town?

A. Yes B. No

32. If yes, how does the family cope with high priced and scarcity of charcoal?

A. Do nothing
B. Making charcoal after using firewood at home
C. Substitute with other source(s) of energy
D. Store charcoal, at a time of low price, through buying
E. Other specify _______________

33. If the family substitute with other source(s) of energy to cope with high priced and scarcity of charcoal, which of the following sources were used as a substitute?

A. Burning "Wayira wood"
B. Fire wood
C. Kerosine
D. Diesel oil
E. Other specify _________________

2.2.3 Other Traditional Biomass Energy Sources (BLT, Tree-roots, Dung, Agri-residues and Saw-dust)

				BLT	Tree-roots	Dung	Agri-residues	Sow-dust
43	Does the family use it?	A	Yes					
		B	No					
44	If yes, the family use it	A	Daily					
		B	Sometimes					
45	How does the family obtain?	A	Through purchase					
		B	Through collect					
		C	From own cattle					
		D	Gift from relatives					
		E	Other ___________					
46	If the family purchases, how much the family pay for consumption during the months June, 1999 & January 2000	Expenditure during January, 2000						
47	If the family collect, from where?	A	Kebele forest					
		B	Peasant association forest					
		C	Grazing ground					
		D	Other _______________					

APPENDIX 3

1. Interviewer Name ____________________
2. Date of Interview (day _______ month ______ year ______)
3. Date of Interview: A ☐ Market day
   B ☐ Non-market day
4. Spot No. where interview is conducted ___________
5. Time the interview is conducted ________________

Part I <u>Age, Sex, Education, Occupation and Residential Address of the Supplier</u>

1. Age _________ 2. Sex __________

3. Educational level: A. Illitrate D. Grade 5-8
   B. Read a write E. Grade 9-12
   C. Grade 1-4 F. Other _____________

4. Permanent Occupation:
   A. Student E. Fuelwood saller
   B. Farmer F. Charcoal saller
   C. Labourer G. No permanent occupation
   D. Housewife H. Other ________________

5. Permanent Residential Address:
   A. In Asella: Kebele __________
   B. Outside Asella: Name of the peasant association or village
   ____

Part II <u>Type of Woodfuel, Source of supply, means of transport, type of tree species and time taken to reach the town</u>

6. The type of woodfuel supplied is:-
   A. Fuel(fire) wood
   B. Charcoal

7. If your answer to question no. 6, is fuelwood, how do you obtained and supply the town?
   A. by cutting your own stand tree to sale it as a fuelwood
   B. by buying stand tree to sale it as a fuelwood
   C. by collecting from wood lands
   D. by cutting from wood lands
   E. by collecting & cutting from wood lands

F. by buying fuelwood to re-sale it for profit
G. other ________________________________

8. If your answer to question no. 6, is charcoal, how do you obtained and supply the town

A. by cutting your own stand tree and preparing it for charcoal to sale
B. by buying stand tree and preparing it for charcoal to sale
C. by cutting wood from wood lands & preparing it for charcoal to sale
D. by collecting wood from wood lands & preparing it for charcoal to sale
E. by cutting and collecting wood from wood lands and preparing it for charcoal to sale
F. by buying charcoal to re-sale it for profit.

9. Means of transport used to supply the town:

<u>Human load</u> — <u>Pack animal load</u>

A. Women — D. Donkey
B. Men — E. Horse
C. Children

10. Where is the source of supply? (write the name of peasant association or village or kebele from where the fuelwood or charcoal came). ___________

11. What is the name of tree species used as a source of fuelwood or charcoal?

____

12. What time is taken by the supplier to reach the town? ________________

Part III <u>Duration of Supply & Seasonal Price</u>

13. Do you supply to the town regularly? A. Yes B. No

14. If your answer to question no. 13, is yes, you supply:
A. Seasonally B. Through out the year

15. If your answer to question no. 14, is seasonally, in which of the following seasons (months) you supply?

A. Septermber – November C. March – May
B. December – February D. June – August

- If your answer to question no. 14, is through out the year, answer questions 15 to 20.

16. You supply to the town:

A. Daily
B. Twice in a week
C. Twice in a week
D. Three times in a week
E. Once in two weeks
F. Once in a month
G. Other specify ___________
____

17. For how long have you been engaged in supplying?

A. Less than 1 year
B. 1 – 2 years
C. 2 –3 years
D. 3 – 4 years
E. 4 – 5 years
F. Above 5 years
G.

18. What was the price situation of fuelwood & charcoal during the last summer and the current winter?

Seasons (months)	Price		
	High	Low	No Variation
Last summer (June, July & August, 1999)			
Current winter (Dec., 1999, Jan., and Feb. 2000			

19. Why the price was lower?

A. due to low demand of the consumers
B. the source of woodfuel (fuelwood or charcoal) is easily accessable and there is no supply shortage
C. Increase in supply due to delay of the rainfall that is, farming activity is interrupted and farmers also became a suppliers.
D. Increase of supply due to the existence of shortage of food which force people to sale woodfuel and generate income for means of survival
E. Other ______________________________

20. Why the price was higher?

A. Very high demand of the consumers
B. Because it was rainy season, and therefore, there is supply shortage

C. Because it was a sowing season, some of the suppliers are involved in farming activity, and there was supply shortage

D. Because it is harvesting season, some of the suppliers are engaged in harvesting activity, which results in supply shortage

E. Because many of the suppliers do not have livelihood problem at this season, so that they don't involved in supply activity

F. Other specify ____

____

DECLARATION

I, the undersigned, declare that this thesis is my original work, has not been presented for a degree in any other University and that all sources of material used for the thesis have been duly acknowledged.

Name Kebede Fufa

Signature

Place: Addis Ababa University

Date of Submission: June, 2000

The thesis has been submitted for examination with my approval as a University advisor.

Kailath Nath Singh

Kailath Nath Singh (Dr.)
June, 2000