

# An Overview of Biomass Energy Usage in Sirnak Province of Turkey

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**Abstract—** In this study, biomass energy utilization in Sirnak, a province located in south-eastern Turkey, was examined. There is not a previous study that clearly reveals biomass usage in this province. The province generates 29.8% of its energy from biomass and other similar resources. The rural households, constituting 37% of total population, consume traditional biomass resources, such as dung, firewood, and plant-based waste. These resources have been primarily utilized for cooking and residential heating in the region. A biomass utilizing household uses approximately 750 dried dung cakes (713-900 kg) per annum. Female members of the families are usually responsible for preparing the dried dung cakes. While households in rural areas mainly collect fuelwood, households in urban areas buy them from local suppliers. An average household living in rural and urban areas usually consumes more than 3000 kg and less than 1000 kg of wood per annum, respectively. Therefore, it can be stated that unsustainable fuel woods consumption in the province is high. Hence, sustainable and modern biomass production techniques are suggested.

**Keywords—***Biomass, Animal waste, Fuelwood, Plant-based waste, Sirnak, Turkey*

## I. INTRODUCTION

Sirnak is a province located in south-eastern Turkey. It has several mountains and rivers with an area of 6904 km<sup>2</sup> (2626 square miles) [1]. According to 2020 estimate, Sirnak has a total population of 538,883 and 37% of population of the province lives in rural areas [2]. Cizre, Idil, Silopi, Uludere, Beytusebap, and Guclukonak are its six districts [3].

In Sirnak, energy is needed for home appliances, lighting, transportation, cooking, heating/cooling, communication, and industrial processes. The province fulfils its energy needs ranging from petroleum products such as asphaltite, and oil to biomass, and hydropower energy [4]. In the recent times, the use of natural gas has increased significantly in limited locations. The city produced 70.1% of its total energy needs from petroleum products; 29.8 % mainly from biomass and other similar resources; 1% from hydropower in 2019. This demonstrates that it largely depends on fossil fuels.

Recently, the province has been investing hydropower and solar energy [4].

## II. ENERGY AND BIOMASS

Energy is one of the key components of socio-economic development and contributes to determining life circumstances of people [5, 6]. The quality of life and living standard of a region could be defined by consumption quality of its energy [5]. From biomass, fossil fuels, and to nuclear power, there are variations in the kinds of energy sources that have been consumed throughout the different stages of development of societies. Environmental concerns and energy security have stimulated the development of renewable energy resources in recent years [6].

The organic components obtained from biological organisms, plants and animals, are defined as biomass that has been consumed as an energy source for thousands of years [5, 6]. Biomass contributes to 10% to 14% of the Earth's energy supply and is a main source of energy [7, 8]. It is generally categorized as woody, non-woody, and animal waste [5]. Biomass can be utilized for electricity generation, biodiesel production, heat energy, and biogas production [9]. Some researches claim that biomass is considered as a form of renewable energy because of not releasing additional greenhouse gas into the atmosphere, others assert that it can be called renewable energy source if it is realistically replaced. For instance, utilizing trees as fuelwood is not sustainable because it can lead to deforestation even though it does not release extra greenhouse gas into the environment. [6, 9].

## III. MATERIAL AND METHOD

Based on many observations in the province and conversations with locals a survey was created. The face-to-face survey was conducted with residences from centres of each district and their rural areas. The survey aimed to reveal biomass energy utilization in urban and rural areas of Sirnak. The Statistical Package for the Social Sciences (SPSS) was operated for analysing the collected data. The analysis of all data was presented in supplemental page. The survey was conducted in the Turkish language and the results were presented in English. The Turkish and English versions of the survey were stated in the supplemental page. Furthermore, during the visits of the rural areas, preparation of the dried dung cakes were performed by the villagers.

#### IV. BIOMASS UTILIZATION IN SIRNAK PROVINCE

Sirnak generates 29.8% of its energy needs mainly from biomass and other similar resources [4]. The rural households, constituting 37% of total population, utilize traditional biomass resources such as dung, firewood, and plant-based waste, in order to supply their everyday energy needs. The types of biomass utilized in urban and rural areas of the province are demonstrated in Figure 1. Biomass is primarily utilized for cooking and residential heating, shown in Figures 3, and 4.

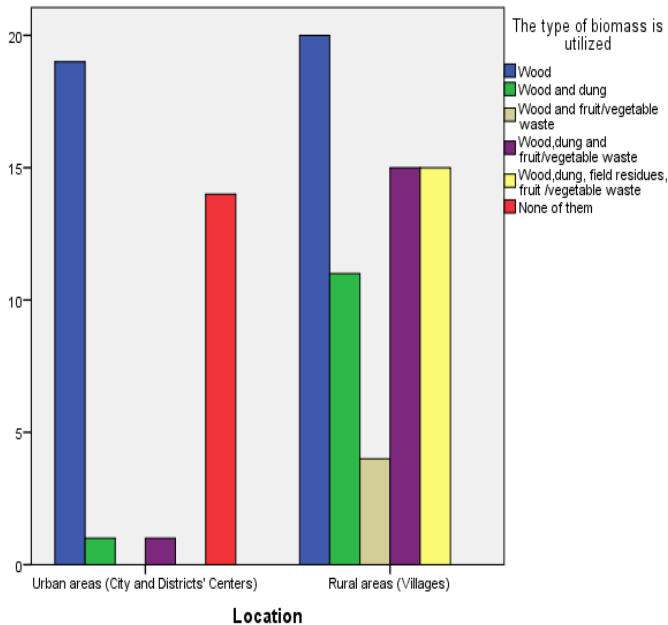


Fig.1. The type of biomass utilized in urban and rural area of the province

##### A. Animal waste

Animal waste is used as an energy source in rural areas and rarely utilized in urban areas, shown in Figure 1. Approximately 67% of the total animal waste comes from cows. Likewise, 31% of the waste is obtained from sheep and goats, and roughly 1% of the waste is produced by poultry, as shown by Figure 2. The total energy value of animal waste produced per year in the province is equivalent to 600 to 5000 tons of oil [10].

The animal manure is collected from pasture or from stables around the village. Animal manure is largely produced by sheep, goats and cows. Villagers give a shape to the dung after or before it is dried. Dried dung in an animal stable is crushed into random pieces with tools, generally a shovel, and accumulated into a pile for storage. Wet dung is moulded into its cake shape by hand using around containers, and water. Prepared dung cakes are piled and left for dry in storages. To increase the mechanical strength of the dung cakes, some villagers mix straw with animal manure [11]. The dried dung is consumed for residential heating and outside cooking, particularly baking bread. Female members of the families are usually responsible for preparing the dried

dung cakes. A household utilizing animal dung makes approximately 20 to 30 dried dung cakes per day and consumes around 750 dried dung cakes (713-900 kg) per annum.

Furthermore, animal manure is collected before drying so that it can be used as fertilizer in the crop fields and gardens. Animal waste is utilized for other purposes, as well. For instance, animal dung mixed with straw is used as supporting material for house walls, roofs and insulation material for walls of animal stables. Also, dried cakes are burned to ward off mosquitos when locals sleep outside.

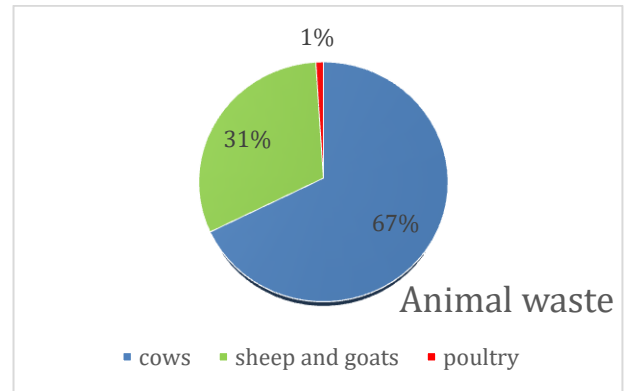


Fig.2. Percentage of the animal waste produced from cows, sheep and goats, and poultry in the province [10]

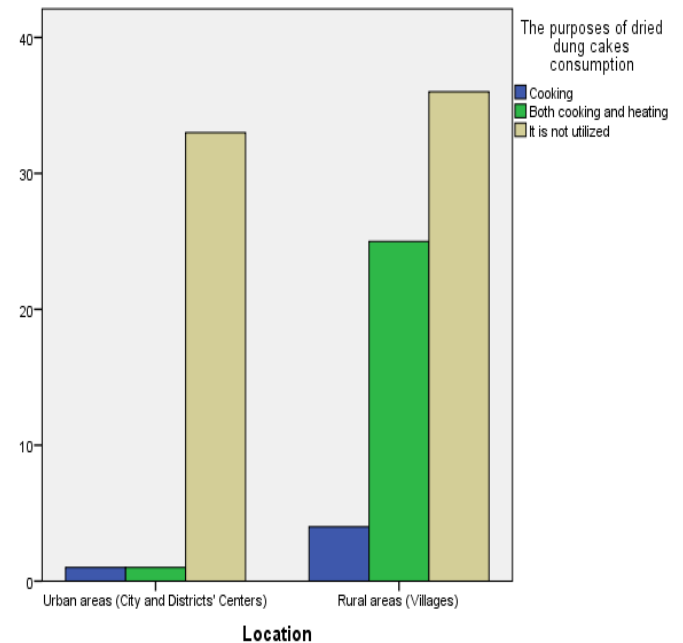


Fig.3. Utilization of the dried dung cakes as an energy source in urban and rural areas of the province.

**B. Fuelwood**

Wood is largely consumed in urban and rural areas for residential heating and outside cooking, see illustration in Figure 1 and 4. An average household living in rural areas consumes more than 3000 kg of wood per annum, but an average household in urban areas roughly utilize less than 1000 kg of wood per annum, demonstrated in Figure 5. While households in rural areas largely collect the fuelwood, household living urban areas usually buy them from local suppliers, displayed in Figure 6. Male members of the families are usually responsible for gathering fuelwood.

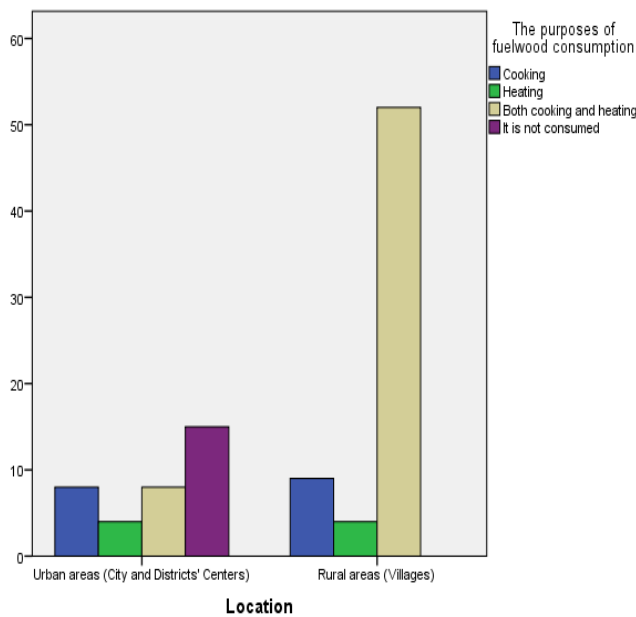


Fig.4. Utilization of wood as an energy source in urban and rural areas of the province.

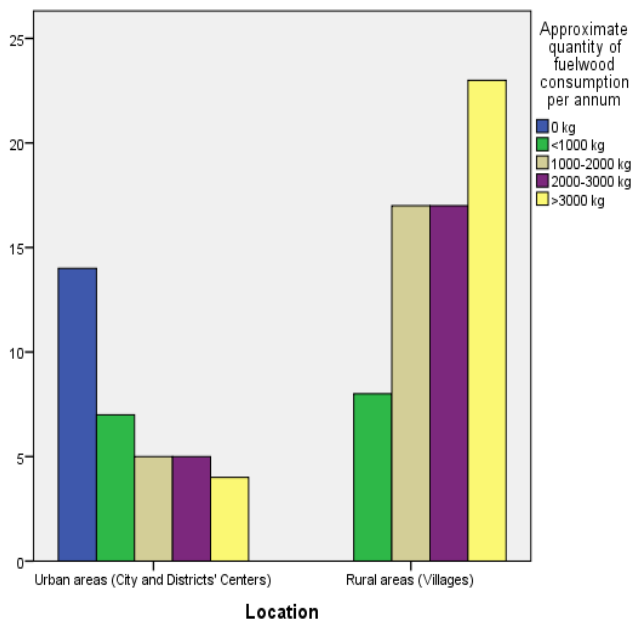


Fig.5. The quantity of wood utilized per annum in urban and rural areas of the province.

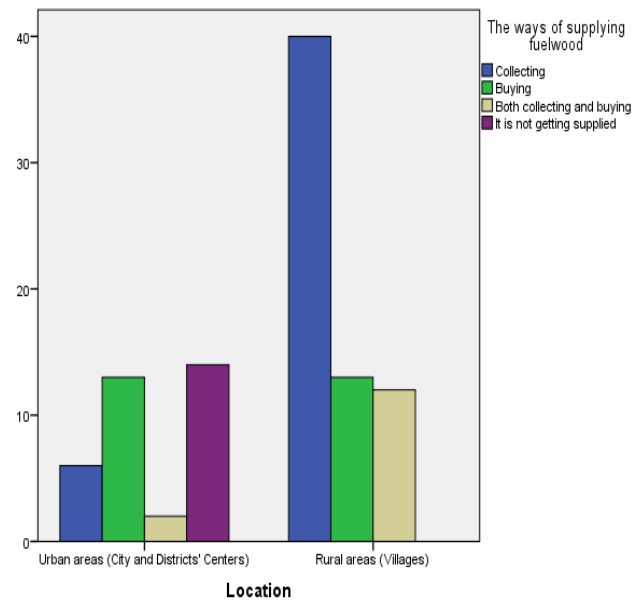


Fig.6. The way of supplying fuelwood in urban and rural areas of the province.

**C. Plant-based waste**

Plant-based waste is utilized in rural areas for residential heating, cooking, animal feed, and fertilizer. Around 91% of the plant-based waste comes from agriculture. 6% of the waste is approximately produced by fruit, and roughly 3% of the waste is created by vegetables, shown in Figure 7 [10].

Crop residues, especially field residues are utilized for residential heating, cooking, and feeding animals. For instance, cotton crop residues, such as stalks, and side branches are collected for residential heating and outside cooking in Silopi and Cizre. Corn and wheat residues, particularly straw, are consumed for animal feed.

The agriculture crop residues in the province could be densified into fuel pellets in order to change its fuel density. However, the pellets are not in production, and are not utilized in the province. Manufacturing of pellets in the province can increase efficiency of crop residues usage because fuel pellets have low and uniform moisture content, great bulk density, high combustion efficiency, and low combustion residues density. Therefore, they can be safely stored and efficiently transported. Moreover, the cost of transportation, handling and storage could be reduced because of the densification of the biomass density [12, 13, 14, 15].

Also, nutshells are utilized for cooking and residential heating in the province. For example, walnut shells are utilized for cooking, especially baking bread, and residential heating in Uludere.

Fruit and vegetable waste are used as fertilizer for gardens and for animal feed. An average household

produces between 50kg and 100kg fruit and vegetable waste per annum.

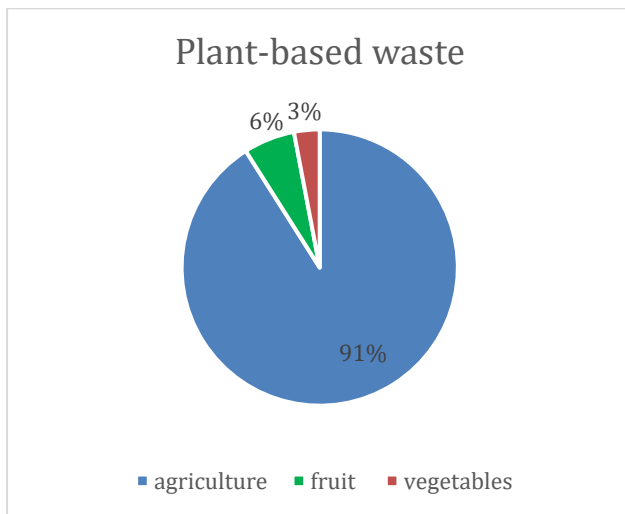


Fig.7. Percentage of the plant-based waste produced from agriculture, fruit and vegetables [10]

## V. DISCUSSION

Unsustainable fuelwood will possibly increase the deforestation in the province in near future. Therefore, the province should adapt to the sustainable and modern biomass energy production technics and decrease fuelwood utilization. Manufacturing fuel pellets from agriculture residues and establishment of biogas plants could be good alternatives.

Currently, hydropower and solar energy plant projects are planned to be built and are in the construction phase. This displays that the province has been investing in renewable energy technologies, and this could decrease energy production from fossil fuels and unsustainable fuelwood utilization.

While female members of the families are usually responsible for preparation of dried dung cakes, male member of the families are mostly in charge of gathering fuelwood. Therefore, it can be said that gender attributes the social role that men and women play, which has a great effect on use and management of biomass energy resources in the families.

## VI. CONCLUSION

Biomass energy utilization in Sirnak province was reported. The province heavily depends on energy generated from traditional biomass sources and fossil fuel. Dung, fuelwood, and field residues are mainly utilized for residential heating and cooking.

## ACKNOWLEDGMENT

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**SUPPLEMENTS***A. English version of the survey***Survey of Biomass Usage in Sirnak Province**

The goal of this survey is to determine the type of biomass energy sources utilized in Sirnak province.

The Survey was conducted by \_\_\_\_\_ Date and time of the survey \_\_\_\_\_

Responder's information	
Name and Surname	
Gender	Female Male
Address	
Phone number	
E-mail	
Location of the house	Urban areas (City/District Centers) Rural areas (Villages)

What types of biomass do you use?										
Only Wood	Only Dung	Only Field residues	Only Fruit/Vegetables waste	Wood and Dung	Wood and Field residues	Wood and Fruit/Vegetable waste	Dung and Field residues	Dung and Fruit/Vegetable waste	Wood, Dung and Field residues	None of them All of them

**Fuelwood**

How much wood do you approximately use in a year?				
0 kg	<1000 kg	1000-2000 kg	2000-3000 kg	>3000 kg
How do you supply the wood you consume?	Collecting	Buying	Both collecting and buying	
Who is responsible for collecting the wood?	Women	Men	Both women and men	
For what purpose do you consume the wood?	Cooking	Heating	Both cooking and heating	

**Animal waste (Dung)**

What kind of animal waste do you use?	Dried dung cake		Wet dung as fertilizer
How is the animal waste supplied?	Cows and horses	Sheep and goats	All of them
For what purpose do you use the dried dung cakes?	Cooking	Heating	Both cooking and heating
Who is responsible for preparing of the dried dung cakes?	Women	Men	Both women and men
Where do you use animal manure as fertilizer?	Farming	Gardening	Both farming and gardening
Who is responsible for collecting the animal manure?	Women	Men	Both women and men

**Plant-based waste****Field residues**

How much field residue do you approximately use in a year?				
0 kg	<1000 kg	1000-2000 kg	2000-3000 kg	>3000 kg
For what purpose do you use the field residues?	Heating		Cooking	Both heating and cooking

**Fruit and vegetable waste**

How much fruit/vegetable waste do you approximately use in a year?	0 kg	<50 kg	50-100 kg	>100 kg
For what purpose do you use the fruit/vegetable waste?	Animal feed		Fertilizer	Both animal feed and fertilizer

## B. Turkish version of the survey

**Şırnak İlinin Biyokütle Kullanımı Anketi**

Bu anketin amacı Şırnak ilinde hangi biyokütle enerji kaynaklarının kullanıldığının belirlenmesidir.

Anketi yapanın adı ve soyadı: \_\_\_\_\_

Anketin yapıldığı tarih ve saat: \_\_\_\_\_

Cevaplayanın Bilgileri	
Adı ve soyadı	
Cinsiyeti	Kadın Erkek
Adresi	
Telefonu	
E-mail	
Evin Konumu	Şehrin/ilçenin merkezinde Kırsal kesimlerde (Köyler)

Hangi biyokütle türlerini evinizde kullanıyorsunuz?										
Sadece Odun	Sadece Hayvan atıkları	Sadece Tarla Atıkları	Sadece Meyve /Sebze Atıkları	Odun ve Hayvan atıkları	Odun ve Tarla Atıkları	Odun ve Meyve /Sebze Atıkları	Hayvan ve Tarla Atıkları	Hayvan ve Meyve/Sebze Atıkları	Odun, Tezek, Tarla Atıkları	Hiçbiri Kullanılmıyor
										Hepsi kullanılıyor

**Yakacak Odun**

Ortalama bir yılda evinizde ne kadar odun tüketiyorsunuz?				
0 kg	<1000 kg	1000-2000 kg	2000-3000 kg	>3000 kg
Tükettiğiniz odunları nasıl temin ediyorsunuz?		Toplayarak	Satın alarak	Hem toplayarak hem de satın alarak
Odun toplama görevini kim üstleniyor?		Kadınlar	Erkekler	Her ikisinde
Odun ne amaçla kullanılıyor?		Yemek yapmak	Evin ısıtılması için	Her ikisi için

**Hayvan atıkları (Tezek)**

Ne tür hayvan atıkları kullanıyorsunuz?	Kuru tezek kalıpları	Hayvan Gübresi
Hangi hayvanların atığından yararlanıyorsunuz?	Büyükbaş (İnek, At gibi)	Küçükbaş (Koyun, keçi gibi)
Kuru tezek kalıplarını ne amaçla kullanıyorsunuz?	Yemek yapmak	Evin ısıtılması için
Kuru tezek kalıplarını hazırlama görevini kim üstleniyor?	Kadınlar	Erkekler
Hayvan gübresini nerelerde kullanıyorsunuz?	Tarlada	Bahçede
Hayvan gübresini toplama görevini kim üstleniyor?	Kadınlar	Erkekler

**Bitki Kökenli Atıkları  
Tarla atıkları ve kalıntıları**

Ortalama bir yılda ne kadar tarla atığı kullanıyorsunuz?				
0 kg	<1000 kg	1000-2000 kg	2000-3000 kg	>3000 kg
Tarla atıklarını ne amaçla kullanıyorsunuz?		Evi ısıtmak için	Yemek yapmak için	Her ikisi için

**Meyve ve sebze atıkları**

Ortalama bir yılda ne kadar meyve ve sebze atığı kullanıyorsunuz?	0 kg	<50 kg	50-100 kg	>100 kg
Meyve ve sebze atıklarını ne amaçla kullanıyorsunuz?	Hayvan yemi		Gübre	Her ikisi için

## C. Analysis of the survey

**Statistics**

		Gender	Location	The type of biomass is utilized	Approximate quantity of fuelwood consumption per annum	The ways of supplying fuelwood
N	Valid	100	100	100	100	100
	Missing	0	0	0	0	0

**Statistics**

		Who collects the fuelwood	The purposes of fuelwood consumption	The type of animal waste is utilized	Where the animal waste is supplied	The purposes of dried dung cakes consumption
N	Valid	100	100	100	100	100
	Missing	0	0	0	0	0

**Statistics**

		Who makes the dried dung cakes	Where wet dung is used	Who collects the wet dung	Approximate quantity of field residue consumption per annum	The purposes of field residues consumption
N	Valid	100	100	100	100	100
	Missing	0	0	0	0	0

**Statistics**

		Approximate quantity of fruit/vegetable waste consumption	The purposes of fruit/vegetable waste consumption
N	Valid	100	100
	Missing	0	0

**Frequency Table****Gender**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Female	46	46.0	46.0	46.0
Male	54	54.0	54.0	100.0
Total	100	100.0	100.0	

**Location**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Urban areas (City and Districts Centers)	35	35.0	35.0	35.0
Rural areas (Villages)	65	65.0	65.0	100.0
Total	100	100.0	100.0	

**The type of biomass utilized**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Wood	39	39.0	39.0	39.0
Wood and dung	12	12.0	12.0	51.0
Wood and fruit/vegetable waste	4	4.0	4.0	55.0
Wood, dung and fruit/vegetable waste	16	16.0	16.0	71.0
Wood, dung, field residues, fruit /vegetable waste	15	15.0	15.0	86.0
None of them	14	14.0	14.0	100.0
Total	100	100.0	100.0	

**Approximate quantity of fuelwood consumption per annum**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 0 kg	14	14.0	14.0	14.0
<1000 kg	15	15.0	15.0	29.0
1000-2000 kg	22	22.0	22.0	51.0
2000-3000 kg	22	22.0	22.0	73.0
>3000 kg	27	27.0	27.0	100.0
Total	100	100.0	100.0	

**The ways of supplying fuelwood**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Collecting	46	46.0	46.0	46.0
Buying	26	26.0	26.0	72.0
Both collecting and buying	14	14.0	14.0	86.0
It is not getting supplied	14	14.0	14.0	100.0
Total	100	100.0	100.0	

**Who collects the fuelwood**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Men	48	48.0	48.0	48.0
Both women and men	12	12.0	12.0	60.0
It is not getting collected	40	40.0	40.0	100.0
Total	100	100.0	100.0	

**The purposes of fuelwood consumption**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Cooking	17	17.0	17.0	17.0
Heating	8	8.0	8.0	25.0
Both cooking and heating	60	60.0	60.0	85.0
It is not consumed	15	15.0	15.0	100.0
Total	100	100.0	100.0	



**The type of animal waste is utilized**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Dried dung cakes	12	12.0	12.0	12.0
Wet dung as fertilizer	12	12.0	12.0	24.0
Dried dung cakes and wet dung as fertilizer	19	19.0	19.0	43.0
None of them	57	57.0	57.0	100.0
Total	100	100.0	100.0	

**Where the animal waste is collected**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Cows/ horses	6	6.0	6.0	6.0
Sheep and goats	25	25.0	25.0	31.0
Cows, sheep and goats	12	12.0	12.0	43.0
it is not utilized	57	57.0	57.0	100.0
Total	100	100.0	100.0	

**The purposes of dried dung cakes consumption**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Cooking	5	5.0	5.0	5.0
Both cooking and heating	26	26.0	26.0	31.0
It is not utilized	69	69.0	69.0	100.0
Total	100	100.0	100.0	

**Who makes the dried dung cakes**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Women	21	21.0	21.0	21.0
Men	4	4.0	4.0	25.0
Both women and men	6	6.0	6.0	31.0
it is not used	69	69.0	69.0	100.0
Total	100	100.0	100.0	

**Where wet dung is used**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Both gardening and farming	31	31.0	31.0	31.0
It is not used	69	69.0	69.0	100.0
Total	100	100.0	100.0	

**Who collects the wet dung**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid Women	2	2.0	2.0	2.0
Men	5	5.0	5.0	7.0
Both women and men	24	24.0	24.0	31.0
It is not getting collected	69	69.0	69.0	100.0
Total	100	100.0	100.0	

**Approximate quantity of field residue consumption per annum**

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid 0 kg	88	88.0	88.0	88.0
<1000 kg	2	2.0	2.0	90.0
1000-2000 kg	10	10.0	10.0	100.0
Total	100	100.0	100.0	

**The purpose of field residue consumption**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Cooking	1	1.0	1.0	1.0
	Both heating and cooking	11	11.0	11.0	12.0
	It is not used	88	88.0	88.0	100.0
	Total	100	100.0	100.0	

**Approximate quantity of fruit/vegetable waste consumption**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 kg	66	66.0	66.0	66.0
	<50 kg	4	4.0	4.0	70.0
	50-100 kg	27	27.0	27.0	97.0
	>100 kg	3	3.0	3.0	100.0
	Total	100	100.0	100.0	

**The purposes of fruit/vegetable waste consumption**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Animal feed	24	24.0	24.0	24.0
	Both animal feed and fertilizer	10	10.0	10.0	34.0
	It is not used	66	66.0	66.0	100.0
	Total	100	100.0	100.0	