

# Waste management in dairy cattle farms in Aydin region. Potential of energy application

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# introduction

- **Nowadays, expansion and intensification of large-scale animal feeding operations have resulted in not only an increase the size of farms but also have an impact on environment and public health. The pollution from farm waste has become a serious problem in rural areas.**
- **According to the FAOSTAT (2016) [1] in Turkey, the most of livestock production belongs to cattle farms (14,223,109 head of cattles). A dairy cattle represents 635.6 billion tons and 82.7% of the total milk production.**

**Table; presents total amount of animal species production in Turkey in last years**

<b>Animal</b>	<b>Unit</b>	<b>2008</b>	<b>2010</b>	<b>2012</b>	<b>2014</b>
<b>Buffaloes</b>	Head	84,705	87,207	107,435	121,826
<b>Camels</b>	Head	1,057	1,041	1,315	1,442
<b>Cattle</b>	Head	11,036,753	10,723,958	13,914,912	14,223,109
<b>Sheep</b>	Head	25,462,292	21,794,508	27,425,233	31,140,244
<b>Chickens</b>	Head x1,000	269,368	229,969	253,712	293,728
<b>Goats</b>	Head x1,000	6,286,358	5,128,285	8,357,286	10,344,936
<b>Turkeys</b>	Head x1,000	2,675	2,755	2,761	2,990

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- The breeding and agricultural activities, especially livestock production on an industrial scale, is seen as one of the main sources of natural environment pollution. Depending on the farming system, animal farms generate solid (dung) and liquid (liquid manure) animal excrements. In these days and age, there is **no-mulch** system becoming more and more popular, particularly in the livestock production on a large scale.
  - Excrement in this system is the so-called liquid manure, i.e. liquid, or semiliquid mixture of faeces, urine, water and feed leftovers.

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- ▶ It is estimated that the cattle residues produced in Turkey reached value 128 million tonnes/year [2]. The amount of wet waste of animals could be a major problem for farms and cannot be utilized properly. The best way to utilize waste is to produce biogas.
  - ▶ The biogas energy potential of Turkey was found to be 2,177,553,000 m<sup>3</sup> (2.18 Gm<sup>3</sup>) based on the animal numbers in the last agricultural census. The total biogas potential is originated from 68% cattle, 5% small ruminant and 27% poultry. Biogas energy equivalence of Turkey is approximately 49 PJ [3].



## The **main** aim of this study

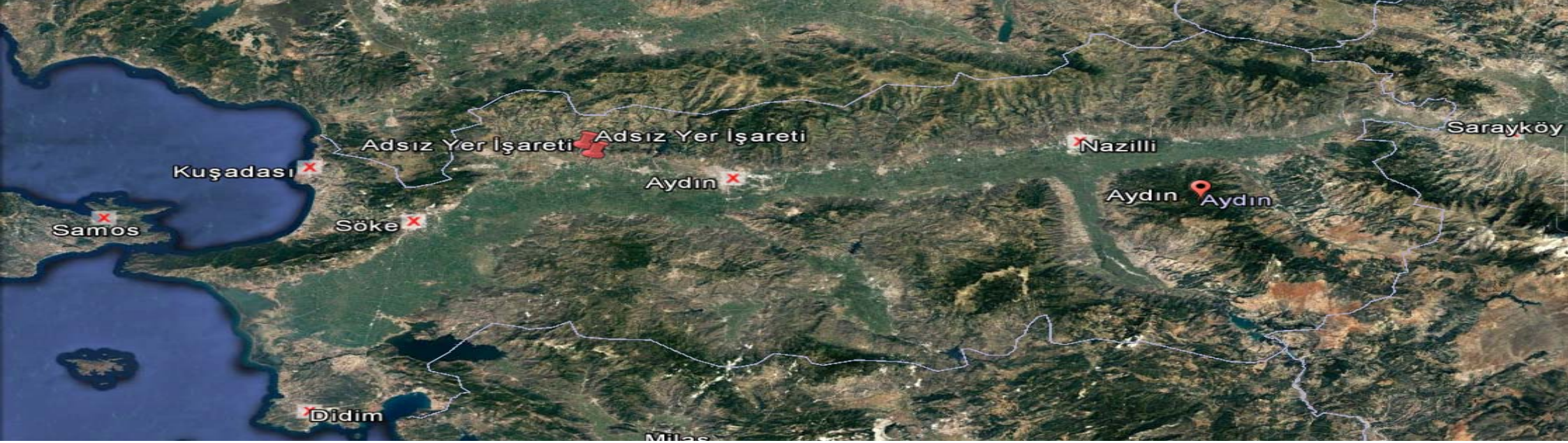
- was not only to investigate the collection and manure management in the cattle farms of Aydin region. Number of farms and livestock size, type of housing, overall farm, type of machinery and a farm labour force and waste management were studied,
- but also determine the energy potential of waste generated on farms. For this purpose, a survey was conducted among owners of farms located in 17 districts of Aydin province.



# Materials and Methods

## Study Area

- ▶ **Aydın province is located in Aegean Region of western Turkey. Total area of province is 8,007 km<sup>2</sup> and the province is divided into 17 districts. In 2013, population was 989 862 with density 120 people/km<sup>2</sup>.**
- ▶ **Cultivated area is 395,494 ha and corresponds to 49.3 % of soil sources. Main agricultural products are fig, olive, chestnut, cotton and fruits. Cereals are cultivated on an area of about 75,000 ha. According to TÜİK [10] in 2010 293,071 heads of cattle were produced.**







**İzmir**

**Manisa**

**EGE  
DENİZİ  
Sisam**

**Kuşadası**

**Germencik**

**İncirliova**

**Aydın**

**Köşk**

**Sultanhisar**

**Nazilli**

**Kuyucak**

**Buharkent**

**Söke**

**Koçarlı**

**Yenipazar**

**Karacasu**

**Karpuzlu**

**Çine**

**Bozdoğan**

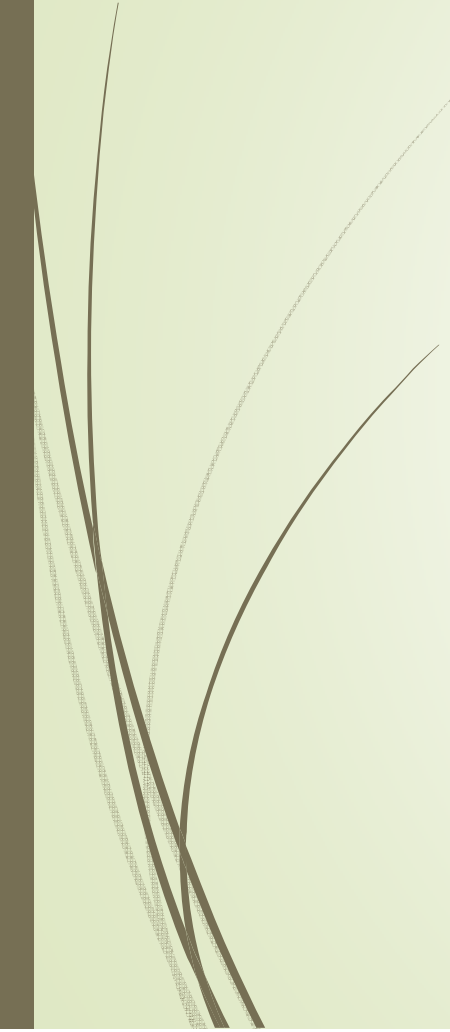
**Didim**

**Muğla**

**Denizli**



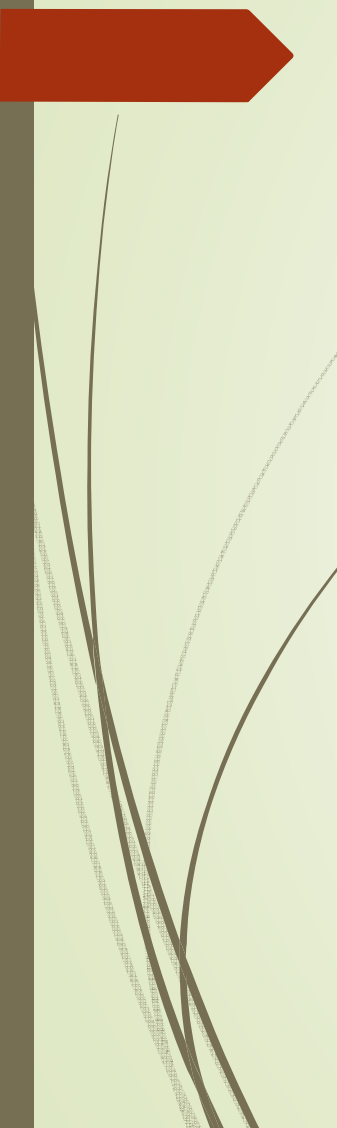
The survey forms (to 87 farms) included such issues as:

- ▶ **livestock size, (as construal)**
  - ▶ **type of housing,**
  - ▶ **overall farm,**
  - ▶ **type of machinery for collecting wastes and a farm labour force,**
  - ▶ **storage manure system,**
  - ▶ **methods of waste application.**
- 



## Results and Discussion

- ▶ In Aydın province most of farms are located in Efeler (18 farms), Çine and Kuyucak (12 farms) and Söke (10 farms). Table 2 presents total amount of cattles in Aydın's districts.
- ▶ Typically farms have more than 100 cattles. 89.6% of the farms have heads ranging from 100 to 200.

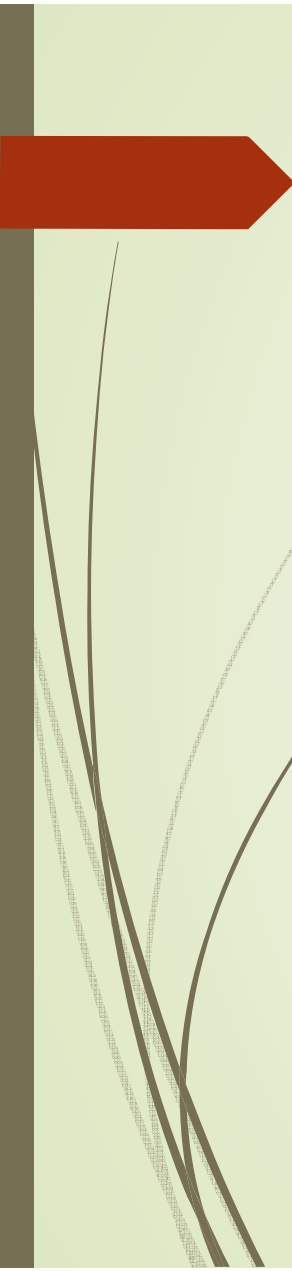



District's	Number of cattles	District's	Number of cattles	District's	Number of cattles
Efeler	34,300	İncirlioiva	9,048	Kuyucak	21,713
Bozdoğan	26,244	Karacasu	10,219	Nazilli	26,000
Buharkent	2,025	Karpuzlu	27,027	Söke	24,145
Çine	62,376	Koçarlı	23,953	Sultanhisar	4,595
Didim	3,047	Köşk	8,757	Yenipazar	17,000
Germencik	19,144	Kuşadası	1,283	<b>Total</b>	<b>320,876</b>

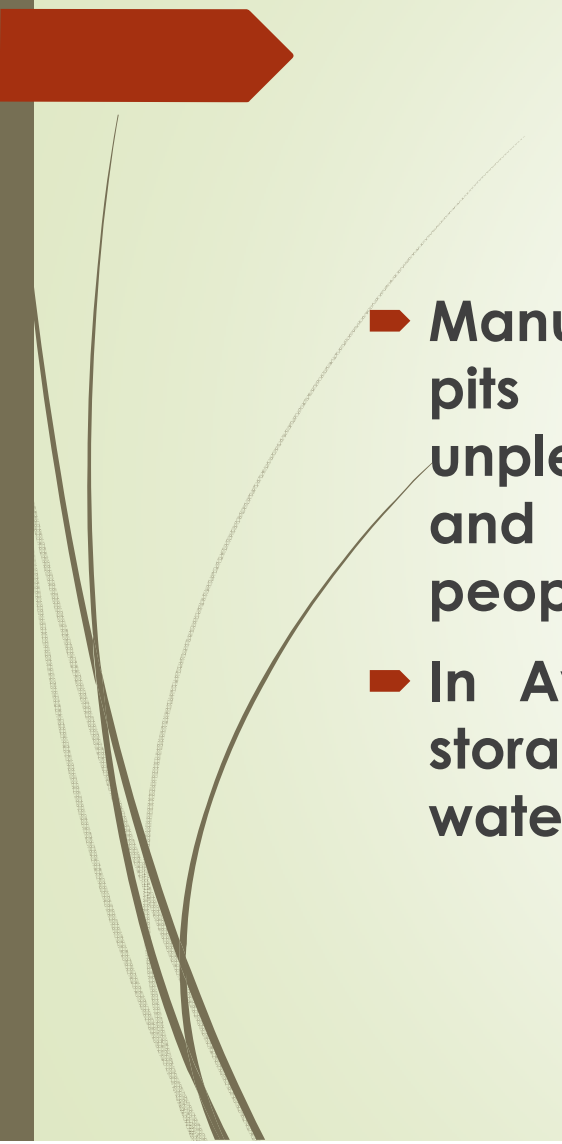
## Results

- ▶ Results of study showed that 48.2% farms have closed-wall barns, 41.4% semi-open barns, and rest of them has open sheltered barn. In figure semi-open barns are shown.



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- **Generally, the one of farm animal waste disposal problem is the collection and holding of manure until it can be utilized on the land. Manure storage facilities in farms should be considered as a temporary solution. The facility must minimize impact on water quality, especially including groundwater and surface water. It is indicated that the manure storage facility should be located at least 100 metres away from water resources [11].**

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- ▶ **Another problem is to minimize odour from manure storage locations, which depends on the size of the intensive livestock operation, the type of livestock or manure management system and time of storing.**

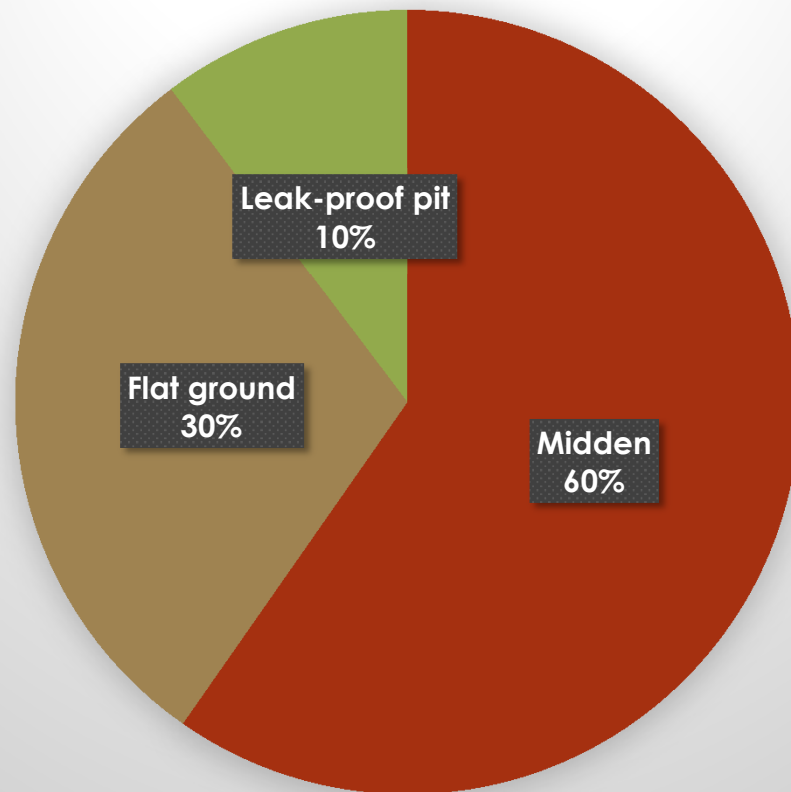
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- ▶ **Manure is usually stored for many months, often in outdoor pits (lagoons). As it decomposes, the manure emits unpleasant gases such as ammonia and hydrogen sulphide and has impact on the health or comfort of surrounding people.**
  - ▶ **In Aydın region the distance between open-air manure storage and water resources as well as source of drinking water supplies is 96 m on average.**




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- ▶ In study area, manure storage facilities are located in the open area. Mostly used type of manure storage is midden (60%), 30% of farms store manure on flat ground and 10.3% on leak-proof pits.

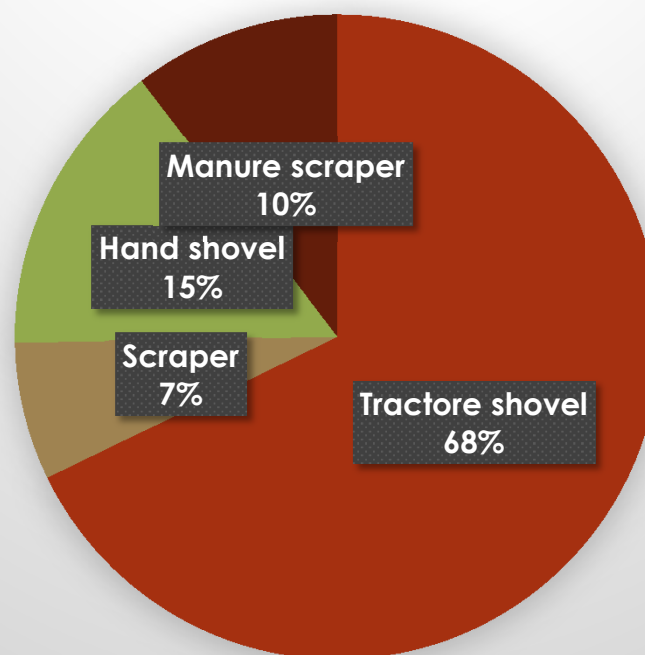


## Distribution of collecting types of manure



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- **The information collected from the dairy farms assessed in this study showed that 67.8% of the farms use tractor shovels for the collection of manure produced in barns. The percentage of manual collection is 14.9%, and there were only 9 farms (10.4% of the farms evaluated) in which the manure was collected with scrapers equipped with chain. 89.7% of the farms do not have any impermeable manure pits.**

## Types of manure collecting systems in studied farms






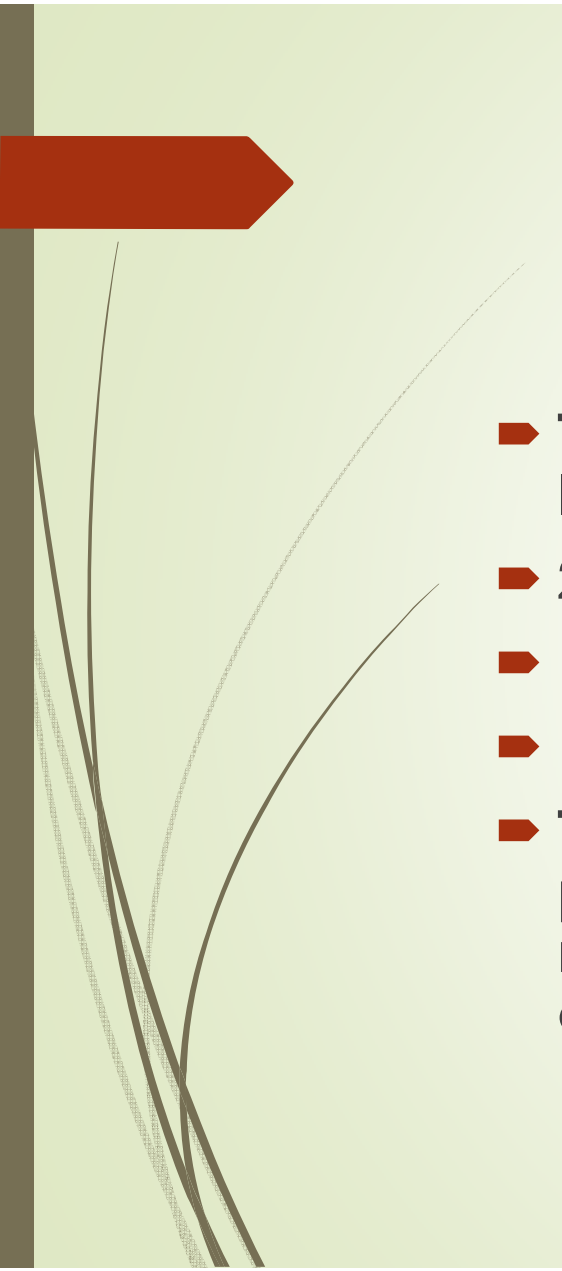
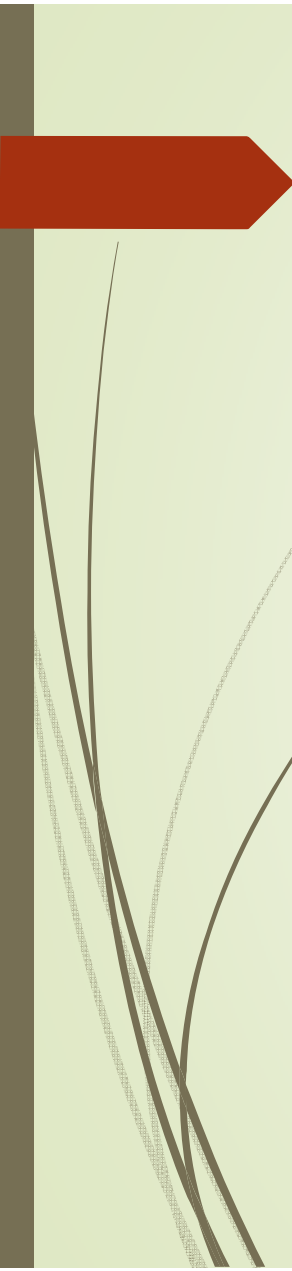
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- ▶ **The most common waste management strategy in farms is the application manure onto the land. All produced manure in studied farms is used in agriculture as fertilizer mostly for own purposes, and only 12.6% farms sell it.**


Table 3 Total amount of produced waste in farms

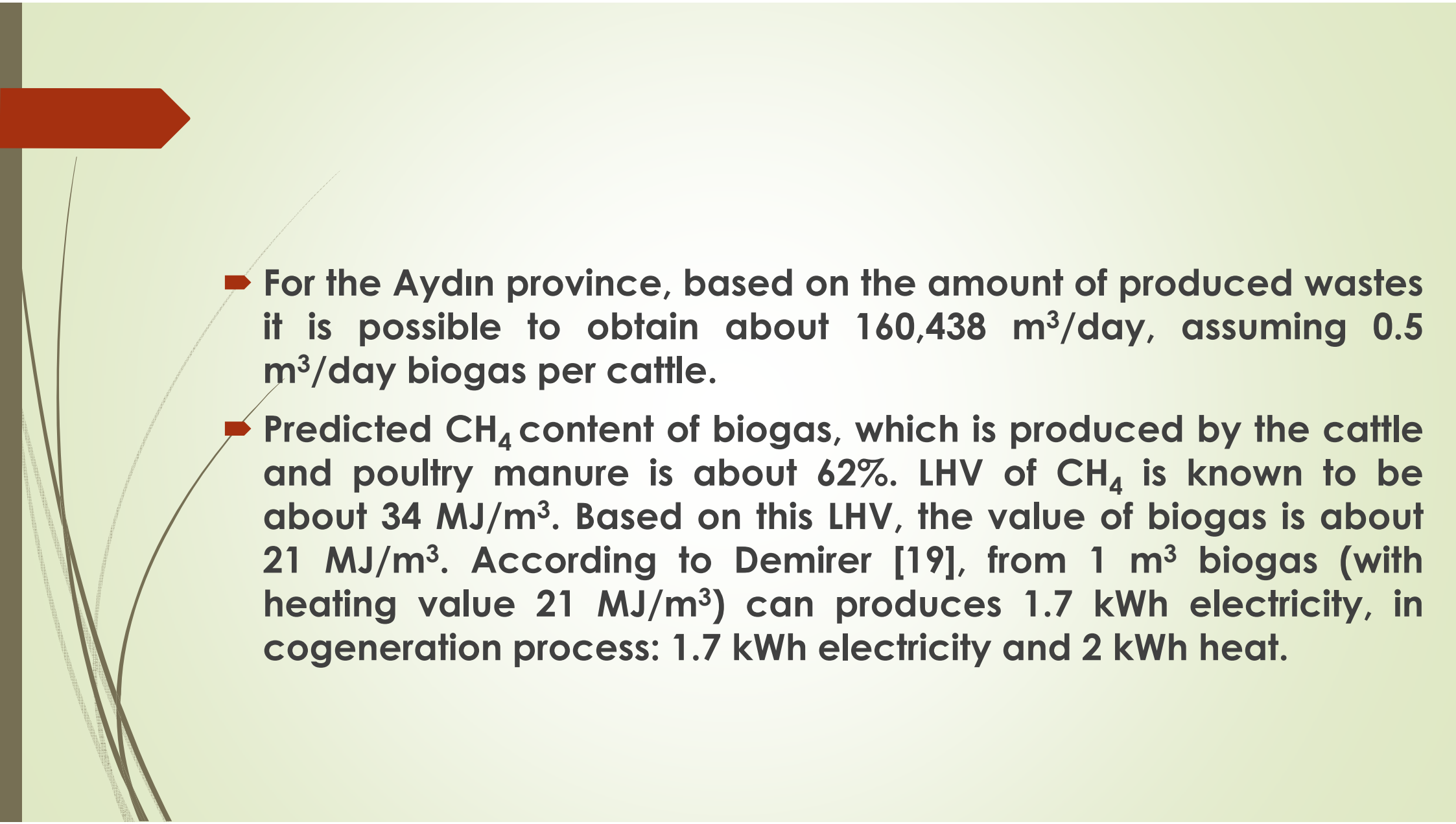
<b>Production of waste</b>	<b>Daily tonnes</b>	<b>Weekly tonnes</b>	<b>Monthly tonnes</b>	<b>Annual tonnes</b>
	13,637.23	95,460.61	409,116.90	4,977,588.95



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- ▶ **The manure can be in solid, solid-liquid and liquid forms. It divided according to content of solids, i.e. above**
  - ▶ **25% - solid fertilizer;**
  - ▶ **10-20% semi-solid and**
  - ▶ **0-10% content of soils is called liquid manure.**
  - ▶ **The studied farms utilize only the solid manure, which provides minimum benefit because of losing organic, nitrogen content during long storage and it can also cause serious environmental pollution.**

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- The production of biogas from manure waste in particular is one of the alternative utilization of organic wastes that can be implemented in this region.
  - The biogas production can have a lot of benefits for environment such as reducing methane and odours emission, which occurs during manure storage, also pathogens and weed seeds are destroyed.
  - From agronomic point of view, transformation of the liquid manure and the manure into a fertilizer (by-product of biogas production) is more easily assimilated by the plants, with a reduction in the odours and the disease-causing agents.

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- **Biogas can be used for heating and electricity production that can give local autonomy in terms of decreasing the cost of fossil fuels. Economic efficiency of biogas plant depends on the investment costs, costs for operating and on the optimum methane production.**

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- For the Aydın province, based on the amount of produced wastes it is possible to obtain about 160,438 m<sup>3</sup>/day, assuming 0.5 m<sup>3</sup>/day biogas per cattle.
  - Predicted CH<sub>4</sub> content of biogas, which is produced by the cattle and poultry manure is about 62%. LHV of CH<sub>4</sub> is known to be about 34 MJ/m<sup>3</sup>. Based on this LHV, the value of biogas is about 21 MJ/m<sup>3</sup>. According to Demirer [19], from 1 m<sup>3</sup> biogas (with heating value 21 MJ/m<sup>3</sup>) can produces 1.7 kWh electricity, in cogeneration process: 1.7 kWh electricity and 2 kWh heat.

**Contains total amount of produced biogas in Aydın and LPG equivalent.**


<b>Daily m<sup>3</sup></b>	<b>Weekly M<sup>3</sup></b>	<b>Monthly m<sup>3</sup></b>	<b>Annual m<sup>3</sup></b>	<b>Equivalent of LPG m<sup>3</sup>/year</b>
160,438	1,123,066	4,813,140	58,559,870	93,895,792

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- ▶ It gives production of electricity on level 99,552 MWh annually. In Aydın in 2012 electricity consumption was 1,860,667 MWh. In the case of using biogas, which can be substitution of conventional fuels, 5.4%, electricity can be cover by biogas.

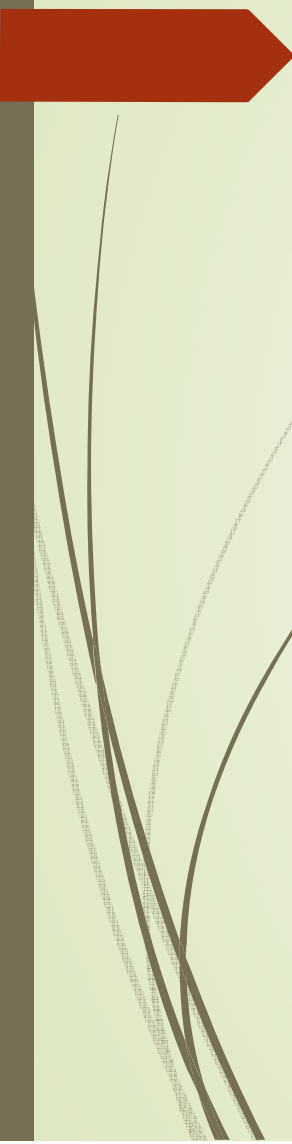



# CONCLUSIONS

- ▶ The animal production sector plays a significant role in agricultural development not only in terms of the products but also because it generates added value and employment opportunities as much as other sub-sectors of agriculture.
- ▶ The difficulties connected with animal production is the waste disposal which involves the system of storing the manure, the odours and gases released, and in some cases, the difficulty of mixing the contents before disposal on the land.

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- ▶ In this study, biogas potential from cattle waste produced in Aydın region was determined and theoretical biogas potential was calculated. This province with the surrounding towns has an economy depending on agriculture and this production.
  - ▶ Results show that representative farm is a facility with a cattle population over 100 heads.
  - ▶ The produced waste is mostly used as a fertilizer on lands of owners. Typical type of storage is midden, which can have a negative influence on environment.



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- **The amount of biogas that can be produced from manure collected in Aydin region is approximately 160,438 m<sup>3</sup>/day, equivalent to about 99,552 MWh/year of electricity, which can be used for own needs of farms owners.**
  - **Conversion of animal waste to biogas through anaerobic digestion processes can provide added value to manure as an energy resource and reduce environmental problems associated with animal wastes.**
  - **It is worth mentioning that dairy cattle manure is endowed with a considerable biogas production that offers numerous benefits of environmental, agricultural and socio-economic standards.**



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**THANK YOU VERY MUCH  
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