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Assessment of Cattle Waste Management Systems Near Settlements in Central Anatolia, Turkey

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Abstract: In this study, waste management systems of various types enterprises in Central Anatolia-Ankara Province and surroundings were investigated, problems were determined and recommendations toward possible solutions were given. Information was taken from the Polat 2007 (Ph.D. Thesis) about waste managment application in research area. It was found that waste management systems of the enterprises were not sufficient and several significant problems were arisen during the storage period. It was also determined that current regulations were not taken into consideration and were not sufficient for environmental protection. Furthermore, new settlement areas and agricultural lands would have several soil and water resources problems in near future. From this point of view, objectives of this study are to try to identify the manure management applications and required strategies in adaptation period to European Union framework directives by giving the studies in European Union for developing countries like Turkey.

Key words: Agricultural pollution, barn, cattle, manure, waste management

INTRODUCTION

As it was all around the world, population moves to cities and population density of the cities have been increasing. It is more than just a simple population increase. Especially due to migrations to big cities, several problems have arisen about drinking water supplies, environmental pollution, recreational areas and waste management issues. Settlement areas of the cities are moving toward the rural areas and this has caused some negative interactions between settlements and agricultural rural areas. The fast rising demand for livestock products has lead to a considerable increase in livestock production, mostly taking place in rapidly growing economies. This results in high environmental pressure (Portejoie and Gerber, 2003).

Livestock waste may seriously pollute air, water, soil and other natural resources. It's mixing with surface waters lowers water quality and may cause the death of sole living organisms in water (Mielke, 1991). Bacteria, viruses and parasites from fecal sources such as slurry or solid manure are of environmental importance as they are stored and handled on farms. Hazards are also associated with the application of wastes to food crops on arable land. The treatment of animals wastes may have to be considered prior to land application so as to allay fears from the food producers and the general public (Williams, 2004). Land spreading of slurry causes significant environmental impact in form of ammonia volatilisation and odour nuisance (Hansen, 2003).

Fulfilling the EU legislation requirements on organic waste management in agricultural and food processing industry can be achieved by carrying out registration and control of organic waste generation in all agricultural and food processing plants, implementation of collection system for organic waste from agricultural and food processing industry, increasing organic waste recycling, applying organic waste treatment methods other than land filling, developing a strategy for sanitary inspection of animal by-products generation and utilization (Malinska, 2004). The Italian national research program had the goal to define and promote new technologies transferable to the industrial sector in view of their production and distribution for agricultural use, in order to define strategies for agronomic valorization of the wastes and develop technological innovations. This, in any case, will also implement the E.U. directives in force. As far as animal slurry is concerned, the goals are as follows; identification of solutions making it possible to eliminate water pollution due to direct discharge of wastes and of new technologies able to reduce and keep under control non point pollution sources through the optimization of the agronomic use of effluents and definition of technological packages for an appropriate field

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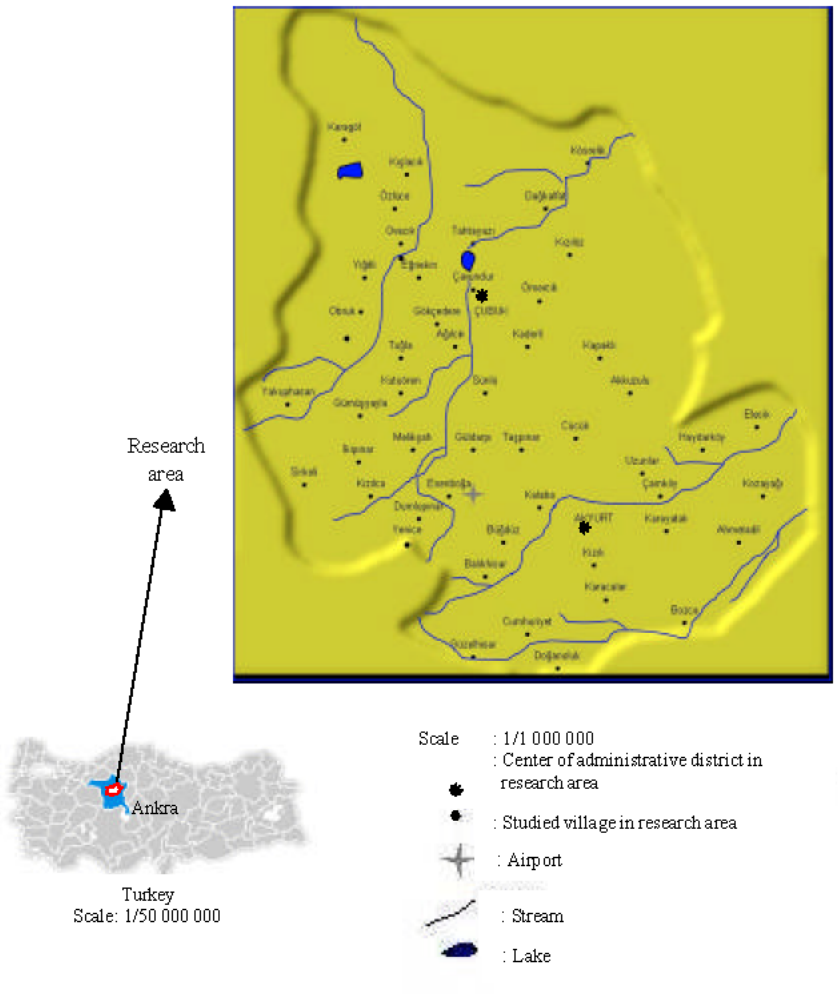

Fig. 1: Map of research area

distribution with low environmental impact. At the end of the research, in particular new prototypes of machines and plants as well as some information programs for the more appropriate management have been designed and constructed (Sangiorgi, 2004).

In Turkey, many of subjects like capacity, animal live weight and species, barn type and planning systems are different from livestock breeding enterprises founded in European Union Member States. In the last form of Environment Law, it has informed that enterprises must have been controlled which has a capacity at minimum 500 for cattle, 1000 for sheep or goat or 60 000 for poultry in one production period. There are a total of 3 076 649 agricultural enterprises in Turkey. Of these agricultural enterprises, 2.4% of them deal with only livestock production, 30.2% with plant production and 67.4% with both livestock and plant production activities. Average number of animal per enterprise is 5 cattle, 15 sheep or goat and 40 poultry animal. From this point of view, capacities of livestock breeding enterprises, reported from renewed Environmental Law, haven't reflected the structure of livestock breeding enterprises in Turkey. Studies show that recent rapid population increases in big cities forced the settlement areas move toward the agricultural lands. On the other hand, number of livestock breeding enterprises with small and medium capacity, around the cities increasing rapidly. Parallel to increase in number of enterprise, amount of waste is also increasing and environmental pollution and waste management issues becoming more and more important. For this reason farmers should be trained about best management practice like waste management, processing and environmental effects. In efforts to adapt to European Union, regulation of Protection of Waters against Pollution caused by Nitrates from Agricultural Sources numbered 25377 have become valid from 2004 February 18th date. So, it has

been taken the first step to begin the environmental friendly agricultural practices for prevention from pollution caused by nitrate in our seas where aquaculture have been practiced and other water sources.

MATERIALS AND METHODS

Accurate data are not available about livestock manure and other wastes production in Turkey. Since sheep herds and beef cattle are grazed in pastures over a period of the year, it is not possible to store the waste produced during these periods. Considering the animal inventory and the periods in which animals are kept inside of the facilities, annual waste production is about 82 million tons. Of this waste production, 75% is used as dried cow dung and used a fuel (called "tezek") in rural areas. Then, only 25% of the total production in Turkey is used as fertilizer in agricultural production (Republic of Turkey Prime Ministry State Institute of Statistics, 1997).

In this study, province of Ankara and surroundings were selected (Fig. 1) as the study area since there are several cattle breeding enterprises in the region and population density also significantly high and there are potential risks of waste management insufficiencies on settlements.

Ankara is located in north-western part of Central Anatolia Region. It has 24 town and 883 villages. Agricultural lands allocate 49.4%, forest and shrubbery 9.6%, pastures 11.8% and lands unsuitable for agriculture 29.2% of the total surface area. Ankara is also located in between forest covered Northern Anatolia and arid Konya Plain. Terrestrial climate is dominant in the region (General Directorate of Rural Affairs, 2000).

There are 71 661 agricultural enterprise in Ankara Province. Among them, 38 481 (53.7%) have a land resource less than 10 hectares (Republic of Turkey Prime Ministry State Institute of Statistics, 2001). New technologies cannot be adopted in these small enterprises due to their high investment costs. On the other hand, new settlement areas are opening in Ankara because of increasing population and high rates of migrations from out of city. That is why; negative effects of the livestock wastes on settlement areas are increasing. Some of these negative effects are the decrease in available soil and water resources, spoil in soil structure, odour problems and esthetical problems.

This study was carried out in four stages as of selection of cattle breeding enterprises, fieldworks and office work as an assessment of fieldworks (Fig. 2).

In this study first of the cattle breeding enterprises were selected. For this purpose animal capacity, type of production, animal race and age, type of housing data for the enterprises were obtained from Ministry of Agriculture records. Table 1 has shown that considerable factors affecting during selection and grouping enterprises.

In order far a better representation of relations of the cattle breeding enterprises with each other, with settlements, soil and water resources, topographical and settlement maps of the study area were obtained from

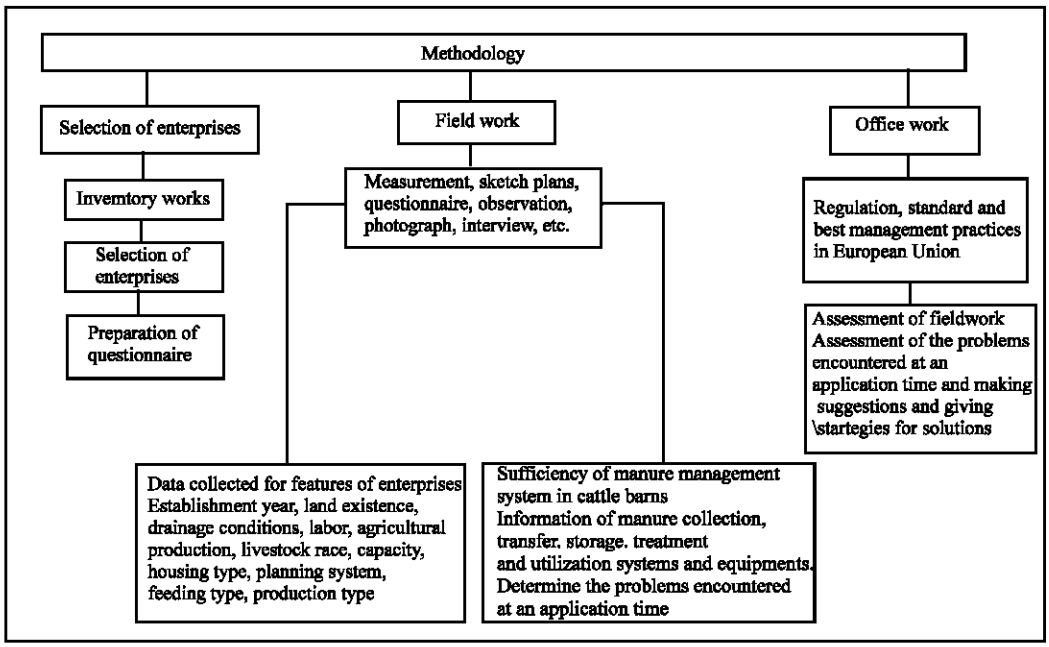

Fig. 2: Methods followed for the research

Table 1: Other considerable characteristics taken for grouping enterprises

Characteristics	Variables		
housing type	Closed	Open	Semi-open
Planning system	Tie-stall	Loose housing	Free-stall / slatted floor
Capacity	1-30 /31-100	101-500	501-↑
Breeding type	Beef	Dairy	Combine
Mechanization	✓	X	-
Topography	Plain	Valley	Hill
Manure storage	✓Earthen Concrete	X	-
Water source	✓	X	-
Location	Town centre	Near centre	Village
Enterprise type	Family	Commercial	-

Table 2: Average values of each group of enterprise's characteristics**

Groups of enterprises	Total liveweight range, t	Total manure production range, t/day	Total N, %	Total P, %
I	0.45-13.65	0.05-1.56	1.070	3.025
II	14.11-45.50	1.61-5.20	1.794	2.315
III	45.96-227.50	5.25-26.00	2.392	2.730
IV	227.96-?	26.05-?	3.102	3.680

**(Source: Polat 2007-Ph. D. Thesis)

General Directorate of Rural Affairs and State Hydraulic Works and they were overlapped. Then, a total of 511 cattle barns belonging to 476 cattle breeding enterprises with different capacities and enterprise characteristics were selected as study material.

RESULTS AND DISCUSSION

Manure production characteristics and general features of enterprises: Cattle breeding enterprises were grouped based on different characteristics and the groups were given in Table 2. Production type of enterprises and housing type-planning system of enterprises have been shown in Fig. 3 and 4.

Cattle spend all their lives in stall in tie-stall barns. On the other hand, they have opportunities for moving in and outside of barns in loose housing systems. In semi-open barns, usually three sides of the barns are closed with walls and a roof placed above the walls. Usually the sides facing south or south-east were left open and an open lot area expanding from this open side is placed. There are not any wall and roof in fully open style.

Group I enterprises are usually located in villages. Traditional clustered settlement culture is dominant in there enterprises and they are adjacent to each other. Family home and production facilities are within a common yard. In this yard, cattle barns are either adjacent to house or placed in lower floors of the houses.

Group II, III and IV enterprises are scatter over the study area. However, some of them are very close to settlements or even left in settlements and established

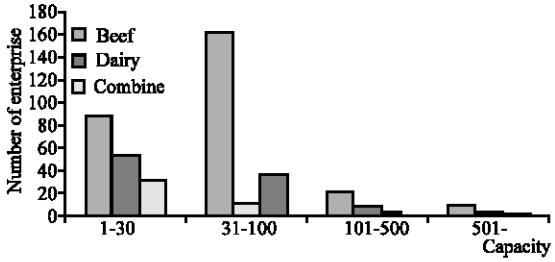

Fig. 3: Production type of enterprises

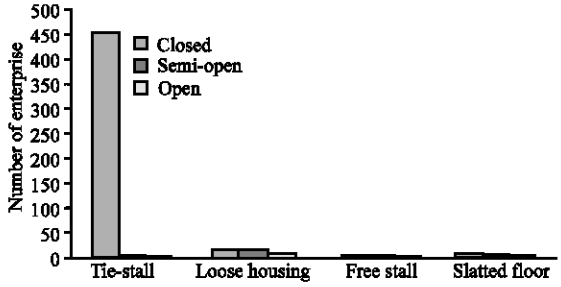

Fig. 4: Housing type and planning system of barns

over the first class agricultural lands. Large amounts of waste production from these enterprises make them critical about environmental effects.

Collection and transfer of wastes: Almost all of the barns in group I and II enterprises are closed and tie-stall type. However in most of them; stall components such as tie installations, standing platform, urine canal and service ways and their dimensions were far away from proper design parameters (Midwest plan service, 1993). In barns without an urine canal, solid and liquid wastes are accumulated over the service alleys between the stalls and scraped with shovels and carried out with vehicles by human power. In the ones with an urine canal, only the liquid waste is carried out via the canal and the solid waste is carried out in the same manner defused above. Since the waste is spreaded over the barn floor, during the collection and cleaning, improper environmental conditions are arisen for both animal and human health. It was also observed that tie-stall floors were some times left as unpaved soil in some barns, with small number animals. In there type of barns, floors are always wet and muddy and this creates an unhealthy environment for the animals.

In group III and IV enterprises; in closed and tie-stall barns in these types of enterprises, stall components and dimensions were more sufficient than the group I enterprises. Liquid waste is removed by the urine canals

and human power is used to remove the solid waste as it was in group I and II enterprises. However, in some barns, scrapers mounted in front of a tractor or mechanical automated scrapers placed in canals were used to remove solid wastes. Environmental effects of waste management system are partially reduced in barns with mechanization.

In group III and IV enterprises constructed in semi-open/open and loose housing systems, manure is stored over the resting and open lot areas and it was scraped one or two times in a year. Scrapers mounted in front of a tractor are used to remove the manure from the barn floor. Especially in open systems, wet conditions are arisen due to liquid manure and rainwater. These conditions increase the foot diseases and dirty the animals. Drainage ditches were constructed in some enterprises to drain liquid waste and rainwater but these ditches sometimes let the manure flow through and contaminate the soil and water resources.

In group III and IV enterprises constructed in closed and loose housing system, manure is stored over stall floors scrapers mounted in front of a tractor is used to remove the manure from the barn. In some barns, flush water is used to clean the barn floor and the water removed from the barn through the canals. In flushing systems, flush water increases the amount of waste and decreases the manure quality.

Barns with slatted-floors had two types; in the first type, animal stalls have slatted-floors, in the second type only the service alleys have slatted-floors. Manure stored in manure canal pits 170 cm below the slats. Manure is stored in pits for about 1-2 months depending on animal capacity in some barns and it is flushed daily in the other to the adjacent manure storage. It was determined that slat upper widths and spacing between them were not sufficient and manure didn't fall down effectively and left over the slats.

Storage of wastes: It was determined that 76.4% of the investigated barns did not have any waste storage facility. None of the group I and II enterprises has a waste storage facility. Waste is stored nearby the barns in small enterprises. In some villages, waste from group I enterprises is stored in an open area in a common place of the village. In group II, III and IV enterprises without a waste storage facility, the waste is stored in an open place around the barn without any precaution for 4-6 months. The liquid waste is infiltrated into soil via the surface flows or flowed into surface waters nearby and caused soil and water pollution.

Among all enterprises, 23.6% has a waste storage facility and mostly the big enterprises have a waste storage facility. About 48.7% of these storage facilities have earthen base and sides, 40.3% have earthen base and concrete sides and 11.0% have logons with concrete base and sides. In some enterprises, some of the waste is stored in these lagoons and the rest separated over the open areas around for about 6 months.

Waste treatment and utilization: Small amount of solid waste in group I and II enterprises is used for enterprise plant production and the rest is utilized as dried dung (called "tezek") for heating.

In group III and IV enterprises, some amount of waste is used in plant production and the rest is given away to commercial fertilizer producers. These producers store the waste, without using any treatment method, in certain places, dry and sieve it then sell it to greenhouses and landscape planners around the region.

Putting drying aside, the waste gathered in research area doesn't go through any physical, chemical or biological treatment (Fig. 5).

- Even though the group I and II enterprises, constituting 1/3 of the investigated enterprises, produce small amount of waste, since they are located close each other in a settlement area, barns are part of houses and they don't have any waste management; they increase the risks on soil and water resources and human health. Together with these negative effects, financial difficulties also exist for waste management facility construction.
- It was seen that inner design of closed and tie-stall barns, constituting about 88.6% of the enterprises in the region, were not sufficient and mostly were not well designed. Since some of them have not any waste storage facilities and some have but with insufficient capacity and not properly designed, not only the waste quality significantly reduce but also several negative effects on environment such as increasing fly population, odour, contamination of soil and water resources. Pollution is a serious concern especially for the enterprises using wells for drinking and utility water.
- During the study, lack of liquid waste management was considered more important for the environmental impacts.
- Considering the water resources pollution, it was seen that current regulations specifying the distances of waste storage facilities from water resources were not adopted sufficiently.
- In commercial fertilizer producing enterprises, waste gathered from surrounding enterprises is stored among the settlements without any precautions taken and it has several negative effects on soil and water resources and settlements due to the surface runoff after each rain.

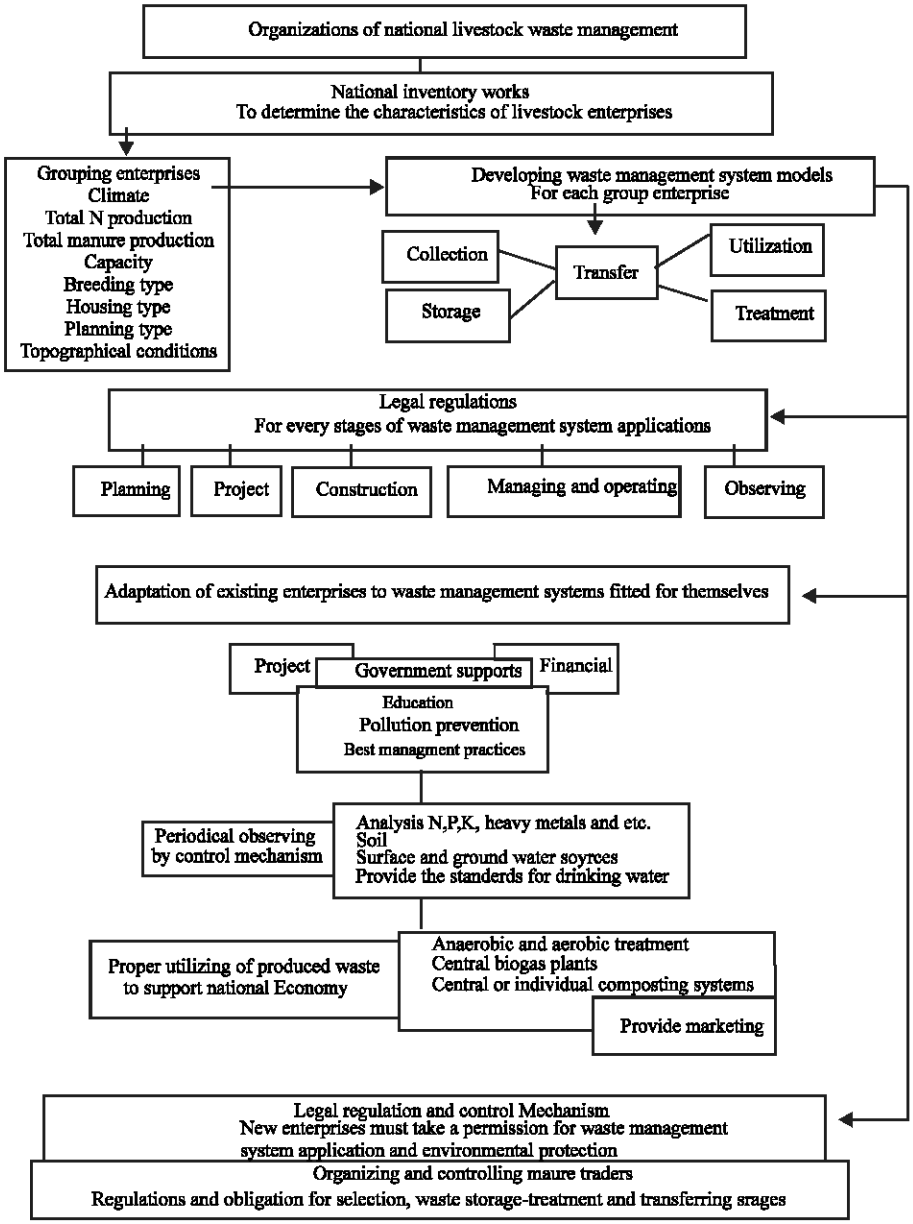

Fig. 5: Recommended strategies for livestock waste management in efforts to adapt to European Union

- Excessive and uncontrolled manure applications on lands spoil the soil structure and increase the deep percolation.
- In slatted-floor barns, waste stored beneath the slats releases gases and odours and due to insufficient ventilation systems these gases and odours cause barn air pollution.
- Since a small part of the manure is used in plant production and larger part is used as dried manure for heating, a significant loses for agricultural production is arisen.
- It was seen that some new settlements were established in some areas closer to 1000 m to current cattle breeding facilities and some were also established on agricultural lands (The Republic of Turkey. Environment Foundation of Turkey, 1999).

Based on the results of the study, following measures can be taken;

- Especially in group I and II enterprises, sufficient liquid and solid waste storage facilities should be

constructed. For group I enterprises, construction of a central waste storage may be more economical because these are very close with each other and obtaining the required area is a serious problem in the region.

- Storage bases and sided should be leak-proof to prevent the leakages to soil and water resources.
- Again in particular group II, III and IV enterprises, closed storages should be constructed for probable air pollution prevention. To prevent the odour and gas release problems, storage systems should be designed in a fashion minimizing the storage surface area. Selecting the fully closed storage structures like tanks is the best management practice.
- To prevent the hygiene and odour problems, barns should be cleaned twice a day minimum.
- Collection and discharge canals should be properly designed to prevent the surface flows in open systems.
- The commercial fertilizer producer enterprises collecting the manure from the surrounding enterprises and storing it open places among the settlements should be reorganized and they should be forced to construct sufficient and proper waste storage facilities and they should operate away from the settlement areas. They should not be allowed to store the waste in open places without taking any precautions.
- For the group III and IV enterprises, biogas or compost facilities should be encouraged since it will provide a natural resource for energy or fertilizers needs of the enterprises and will also let the enterprises to reuse the waste from biogas production in plant production. In addition this, compost production will strengthen the economies of agricultural enterprises.
- Current regulations about topography, geological structure, soil and water resource utilization and distances from water resources and settlement areas all should strictly be taken into consideration in placement of cattle breeding enterprises and waste storages.
- Waste water coming from rain drains, flush water and milking centres should be stored in a separate place in waste storages.
- New settlement should not be allowed to be established at a distance less than 1000 m to current cattle breeding facilities. Cattle breeding enterprises very close to the current settlements may be closed. Based on the legal regulations, solid waste storages must be placed minimum 1000 m away from the nearest settlement (The Republic of Turkey. Environment Foundation of Turkey, 1999).
- The areas with potential environmental risks from livestock wastes should be determined; soil and water resources should be monitored regularly. Maximum 50 mg L^{-1}, preferly 25 mg L^{-1} N level must be provided in drinking and surface waters
- Concerning the water resources pollution, solid waste storages must be placed minimum 10m away from the surface water resource and drainage systems and 50 m away from the wells. (Association of Environment, 2001; European Union, 2000; Department of Agriculture and Rural Development, 2005).
- Concerning the solid waste land application, it must be applied minimum 250 m away from drinking water resources. (The Republic of Turkey. Environment Foundation of Turkey, 1999; European Union, 2002; Department of The Environment and Department of Agriculture and Rural Development, 2005).
- Farmers should be trained about waste management, processing and environmental effects.

CONCLUSION

In Turkey, studies and applications of Nitrate Directive has been just begun, although beginning in 1980's in European Union . However, much observing, measurement and controlling were started, national livestock breeding inventory should be obtain and waste management standards should be developed from the direction of results of inventory works. In conclusion of research, it has been recommended that the last form of Environmental Law should be rescrutinized and should be fitted for Turkey's conditions. More detailed standards have been applied in European Union and United States of America than Turkey, while examining the livestock waste management issues. For example, in soils, required maximum loads of N and P are in orderly 170 kg/ha/year and 20 kg/ha/year; for drinking waters, should be provided maximum nitrate level is at 50 mg L^{-1}, preferably at 25 mg L^{-1}, application timing obligations, storage period and structural standards, restrictions for land application in different climate conditions and for animal capacity and density and like these a lot of issues should be put into practice in efforts to adapt to European Union for developing countries like Turkey.

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