INFRASTRUKTURA I EKOLOGIA TERENÓW WIEJSKICH
INFRASTRUCTURE AND ECOLOGY OF RURAL AREAS

No I/1/2022, POLISH ACADEMY OF SCIENCES, Cracow Branch, pp. 61-73
Commission of Technical Rural Infrastructure

Funda YOLDAŞ[*1], Yücel ÇARDAKÇI[2], Atılgan ATILGAN[3]

VEGETATIVE MEASURES REGARDING ANIMAL MANURE MANAGEMENT BASED WATER POLLUTION; SUSTAINABLE AGRICULTURAL INFRASTRUCTURE AND INNOVATIVE STRATEGIES WITHIN THE EXAMPLE OF KÜÇÜK MENDERES BASIN

ABSTRACT

In Turkey, the renewable water potential per capita is rapidly decreasing in response to the increasing population. Of the 234 billion m³ renewable water potential of our country, 41 billion m³ consists of groundwater and 193 billion m³ consists of rivers. One of the measures to be taken in order to protect renewable water resources in our country, which is not rich in water, is to try to minimize the damage to ground and surface waters caused by solid and liquid wastes that occur in animal shelters. This damage occurs especially with the washing of negatively charged nitrate in the fertilizer content by factors such as precipitation and the increase in the nitrate level of water resources. For the prevention and reduction of environmental problems arising from the said polycultural enterprises; Ecological evaluation of the transition to sustainable farming methods is one of the elements of urgency for the ecological sustainability of animal husbandry. In this study; the definition, scope and briefly the principles of sustainable agricultural methods for the management of nitrate pollution, which is one of the most important parameters that cause water pollution from agricultural production, are emphasized, the reasons for the transition to sustainable agricultural methods are explained, and the necessity and applicability of closely monitoring these developments in İzmir, which has a great potential in terms of animal existence, has been

1 Organic Agriculture Programme, Ödemiş Vocational High School, Ege University, Ödemiş, İzmir, Turkey https://orcid.org/0000-0003-2397-6009
2 Department of Agricultural Structure and Irrigation, İzmir Directorate of Provincial Agriculture and Forestry, Republic of Turkey Ministry of Agriculture and Forestry, İzmir, Turkey https://orcid.org/0000-0001-6205-9751
3 Alanya Alaaddin Keykubat University, Engineering Faculty, Department of Biosystem Engineering, Alanya, Antalya, https://orcid.org/0000-0003-2391-0317

discussed on a basin basis. In addition, in terms of different animal production branches, the situation of animal manure management infrastructure together with plant production has been evaluated and some suggestions have been made with innovative strategies on the basis of basin that can be an example pilot.

Keywords: *Vegetative measures, animal manure infrastructure, water pollution, sustainable agricultural practices*

INTRODUCTION

Agricultural production which has been the basic source of life since the beginning of the civilizations is facing serious problems today. Rapidly growing world population require more and more nutrition each day. On the contrary, enlargement possibilities of arable areas are very limited and more arable lands can be created only by destroying wildlife habitats. In this case the only reasonable way to increase agricultural production is acquiring more production per unit area, in other words increasing the productivity.

However, practices and methods to increase productivity are accompanied with some negative consequences. Productivity of the land decreases because of frequent cultivation and chemicals used for fertilizing and plant protection may have negative effects on the product and the land (Pezikoğlu, 2006; Yoldas et al., 20011).

In 21st century, achieving the desired increase in productivity by overcoming the effects of negative environmental circumstances will be the crowning glory of agriculture. This can be possible only with sustainable applications and permanent solutions in agriculture (Turhan, 2005).

From the definition of sustainable development, sustainable agriculture is defined as "developing and applying agricultural methods that do not disentitle the future generations' right to satisfy their nutrition needs while satisfying current needs". According to this definition, sustainable agriculture includes systems and applications that improve the production of sufficient and quality nutrients for growing world population with lower costs and protection of nature and agricultural sources (Aksu, 2011).

Thus, traditional agricultural applications have been left in our country and use of advanced techniques, technologies and mechanization applications related to plant and animal breeding, plant and animal production and construction. The development has ended up with better revenues for agricultural producers in our country, just like in the rest of the world, as a result of increase in efficiency of agricultural production. However, we counter mismanagement of agricultural waste as one of the most significant problems in Izmir. Indeed according to Agriculture and Forestry Provincial Directorate of Izmir's studies, 90% of medium and large sized (producing more nitrate than 3500kg annually) enterprises' fertilizer management planning and facilities are not conforming to standards and they have land fertilizing management application and similar problems. Such problems cause nitrate pollution in water sources when chemicals, especially nitrate, in the fertilizer are washed with rains or other factors. Therefor the responsibility of the producers is not only increasing the productivity but also protecting the environment and improving cultural heritage activities. In order to solve the problems and maintain positive activities the agricultural producers must follow the regulations called "Sustainable Agricultural Applications".

In our country, good agricultural practises code is based on the 7th article of Regulation about Protecting the Waters Against Agriculture-Based Nitrate Pollution published in Oficial Gazette number 29779 dated 23 July 2016 and it includes agricultural methods related to prevention of water pollution by agricultural production systems and applications aiming to minimize the risk of nitrate pollution in water. Agriculture based water pollution usually occurs as nitrate in chemical and animal fertilizers is easily washed out and mixed into water sources as it is

anionic. Therefore, sustainable agricultural applications related to pollution of water sources must be based on nitrate pollution in water management. In this way, other farming and husbandry related pollution parameters which are caused by less washable compared to nitrate will be held under control **(**Benzer and Benzer, 2018).

Good agricultural practices code that aims to reduce agricultural activities-based nitrate pollution in water are regulated considering different terroirs in our country and include some certain regulations that involve the following elements:

1. The periods that are not suitable for fertilizing the land.
2. Fertilizing conditions to waterlogged soil, flooded lands and areas covered with snow.
3. Fertilizing conditions of the soil close to waterbeds and water sources.
4. Description of qualifications and capacity and construction of the storage units that aim to prevent the water pollution in form of surface flow or infiltration to underground of water leaked from plant materials like stored animal manure and silage.
5. Defining application methods ensuring the amount to be washed out and infiltrated to water is at an acceptable level by defining the right application amounts of animal and chemical fertilizers and providing homogenous distribution of fertilizers to the soil (Good agricultural practices code).
6. Animal or chemical fertilizers must not be applied to soil with no plants on it, except sowing period. The measures for surface flood and erosion control must be determined by considering critical slope gradient, rainfall, flora and texture. During irrigation, surface flow that pollutes the water sources must not be allowed and over-irrigation that cause leakage deep under the roots must be prevented.
7. Proper techniques must be used in the management of Salty-alkalic and acidic soil.
8. Sloping lands and areas with high risk of erosion must not be cultivated. If they are to be cultivated, plant that exploit a lot of nitrogen from the soil must be planted.
9. Cultivation must be right angled to the angle of gradient in the sloping lands. Time of cultivation must be determined considering humidity of the soil. 0,5 meters wide area must be left uncultivated between the parcels in the high gradient lands. The plants to be planted must be chosen among the plants that grows easy and fast and also with roots going deep underground.
10. Crop alternation must be planned considering the production pattern suitable for the basin.
11. Fertilizers must be prevented of being washed out and reaching water sources by creating a rugged terrain or leaving a strip shaped planted land along the water sources.
12. Plant protection products must be applied when needed according to the economical threshold value determined by examining the intensity and biology of diseases and pests, and phenology of the plants (Good agricultural practices code).

Since this study aims to run sustainability analysis of animal husbandry based water pollution according to the Good Agricultural Practices Code, *the rules within good agricultural practices code* given above are the main environmental vegatative measures. The necessity and feasibility of starting models in the basin as pilot applications and suggestions are made based on the evaluation of the current situation.

MATERIAL AND METHOD

MATERIAL

Cattle farming enterprises that produce more nitrate than 3500 $kg \cdot year^{-1}$ and located in Bayındır, Beydağ, Kiraz, Menderes, Ödemiş, Selçuk, Tire and Torbalı all of which are in Küçük Menderes Basin in Izmir are chosen as the material of the study. The study was conducted among 2627

existing enterprises that produce more than 3500kg nitrate annually according to the Ministry of Agriculture and Forestry' Provincial Directorate of Izmir (Table 1).

Table 1. Numbers and distribution of the enterprises selected for the project in Küçük Menderes Basin

DISTRIBUTION OF THE ENTERPRISES THAT PRODCE MORE THAN 3500KG NITRATE PER YEAR IN KÜÇÜK MENDERES BASIN					
TOWN	**TYPE OF ENTERPRISE**				**TOTAL**
	Cattle	**Sheep&Goat**	**Poultry**	**Mixed**	
Bayındır	380	-	11	101	492
Beydağ	40	-	-	-	40
Kiraz	313	-	9	-	322
Menderes	68	6	7	37	118
Ödemiş	450	250	100	56	856
Selçuk	6	2	-	-	8
Tire	550	-	18	118	686
Torbalı	79	-	-	26	105
GRAND TOTAL	**1886**	**258**	**145**	**338**	**2627**

The material of the study consists of cattle pens, manure facilities, systems that are related to vegatitive protection and measures within fertilizing management. A brief information about location, climatology, landscapes and floral features and agricultural production conditions are provided below.

METHOD

The research was carried out in three stages: selection of cattle breeding enterprises, field studies and office studies.

Identification of the Enterprises where the Project will be Executed and Data Collection:

The Ministry of Agriculture and Forestry issued the "Good Agricultural Practices Code Communiqué for the Prevention of Nitrate Pollution from Agricultural Activities in Waters" on February 11, 2017, in order to regulate the procedures and principles to be followed by farmers in order to prevent or reduce nitrate pollution in waters caused by animal production activities and other agricultural activities in cattle farming enterprises. According to the communiqué, existing livestock enterprises producing nitrogen of 3,500 kg or more per year are obliged to make animal fertilizer storage and fertilization plans within 4 years from 2017 in accordance with the "good agricultural practices code" of the Communiqué addexe. The new livestock enterprises should be planned in accordance with the code of good agricultural practices (Atılgan et al., 2012).

The most important issue brought about by this new situation; A total of 3024 livestock enterprises in İzmir that produce 3500 $kg \cdot year^{-1}$ nitrogen and more are obliged to make a fertilizer warehouse and animal fertilization plan that provides storage in accordance with the conditions specified in the said regulation. However, there are no mechanisms to carry out innovation studies with R&D, which provides convenience in these applications that are new for livestock enterprises.

For this reason, the study was carried out by determining the number of livestock enterprises producing nitrogen of 3500 kg·year^{-1} and above in the Küçük Menderes Basin. In the questionnaire prepared with the aim of collecting technical data for the Cattle Livestock Farms, the farmer/operator information consists of questions about whether the farm's warehouse is leakproof and whether there is a fertilizer management plan.

Evaluation of Studies and Data related to Enterprises:

During the office studies phase of the research, the results obtained from the field studies were evaluated. As the result, innovative manure management systems that may be suitable for cattle breeding enterprises in the research area were proposed, and feasibility was carried out through sample enterprise business planning for the animal manure management system.

Since the aim of this Project is to carry out sustainability analysis for animal husbandry-related water pollution management according to the Good Agricultural Practices Code, "the rules within the scope of the Good Agricultural Practices Code regarding manure storage and fertilizer management plans of livestock enterprises" are given after examining them in their entirety within the framework of sustainable environmentally oriented water pollution management practices. In this analysis, the infrastructure of livestock enterprises, which are agricultural enterprises that form the basis of rural physical existence, has been examined according to Good Agricultural Practices Code, and it is aimed to explain the ways of sustainable strategic spatial planning of the results according to cultural-technical engineering (Polat and Olgun, 2009).

Accordingly, the agricultural activities of enterprises producing 3500 kg/year of nitrogen in the Küçük Menderes Basin will be discussed. Individual factors that put sustainable water management at risk and ensure sustainability in the basin have been examined individually. Indicators that are tried to be obtained from the enterprise owners and planned to be measured afterwards, for the said examination in the project:

1. Manure Storage
2. Safe Use of Fertilizer
3. Use of Soil Water Conservation Methods
4. Vegetative Methods
5. Place of Establishment of the Enterprise
6. Enterprise Locations and Distribution in the Küçük Menderes Basin

RESEARCH FINDINGS AND ANALYSIS ON THE TRANSITION OF LIVESTOCK ENTERPRISES TO MANAGEMENT OF NITRATE POLLUTION IN WATER

In this final text section of our project work, agricultural activities in the Küçük Menderes Basin will be discussed from the perspective of sustainable agriculture and the Good Agricultural Practices Code. Sustainable agricultural practices and the factors that risk sustainable agricultural activities and ensure sustainability in the basin will be examined one by one, and the integrity of the subject will be tried to be ensured.

In order to calculate the total nitrogen production that may be a risk to water resources due to the fact that it is carried out in mixed livestock with cattle livestock in the enterprises examined, the number of these animals in cattle unit (CU) was learned from the land and the total nitrogen production (kg·year^{-1}) of the enterprise was found and their casting was given in Table 2.

Table 2. Annual Nitrogen Amount of Enterprises in the Project Area and Influencing Factors

TOWN	Project Site Annual Nitrogen Amount and Influencing Factors				
	Number of Cattle Enterprises	**Number of CU**	**Annual Nitrate Amount**	**Number of Enterprises with Fertilizer Storage**	**Enterprises Running Sustainable Fertilizer Programs**
Bayındır	380	46.867,84	3.304.186,30	4	None
Beydağ	40	3509	245.654,50	2	None
Kiraz	313	30034,75	2.102.433	4	None
Menderes	68	1062,7	893761,4	5	None
Ödemiş	450	94878,28	6641480	10	None
Tire	550	57011,32	3990792	2	None
Torbalı	79	13300,82	931057,4	23	None
Selçuk	6	1205,2	84.364	5	None
GRAND TOTAL	**1886**	**247.869,91**	**18.193.728,60**	**46**	**-**

In this section, vegetative methods (mulching, good agricultural practices, erosion, legume cultivation, crop rotation, etc.) in cattle farming enterprises in which research is carried out, structural and functional characteristics of shelters, amounts and characteristics of fertilizers arising in shelters, the effects of findings on the collection, transmission, storage and evaluation of the resulting fertilizers and other wastes on environmental pollution and the adequacy of their compliance to Good Agricultural Practices Code is discussed.

İzmir is very suitable for animal husbandry in terms of natural resources and ecological conditions. However, low yield and living conditions prevail in the countryside as a result of factors such as insufficient use of applied technology and basic input, impaired soil distribution and the absence or the lack of rural infrastructure. The elimination of this aforementioned situation often requires a comprehensive "Rural Settlement Arrangement".

It is possible to divide the rural settlement problems, the nature of which varies from country to country, into three groups. One of them is the elements of settlements in general; Being a business courtyard, agricultural land and social service structures are problems arising from location and distribution, others are physical problems with socio-economic problems of rural settlements, respectively. Agricultural production is the main function in rural settlements where these said problems are examined.

Within this context, the most significant problem in the rural areas of Izmir is the high risk of animal production-based nitrate pollution in the water sources when the amount of nitrate produced annually combined with the fact that 95% of the animal production constructions lack proper and leakproof storage facilities because of distribution and location problems. The incident is classified as physical problems in rural areas and it requires planning of Animal Farms (barn yard). Additionally, in order to prevent nitrate pollution in water and protect water sources, animal production construction must be established considering the fertilizer management flow diagram.

The potential solution for this physical problem in animal production which cause nitrate pollution in water sources is “good agricultural practices code” which include cultural-technical engineering, which is based on engineering knowledge and techniques based on agricultural culture and vegetative measures (building sets and terracing, plant fences, ditches and holes, mulching with stones, mixed sowing, planting trees for shadow, sowing the plants parallel to the slope gradient will produce less erosion. Mixed sowing and alternation of grains with legumes help the

soil regain its productivity and decreases the need for nitrogen fertilizer. Mulching the soil and adding compost and animal manure enrich the soil by means of nutrition and organic materials and support worms and other soil ecology. Stopping the flow of the water, holding the soil and slowing the wind by planting grass, bushes or trees is another vegetative measure).

The main principals of the code for sustainable agriculture is as follows;

All animal manures (solid fertilizer, liquid fertilizer and liquid animal manure/slurry) and liquid waste must be gathered and kept in a safe place until they are applied to the field in animal husbandry enterprises by preparing extensive Sustainable Fertilizer Management Plans. Besides nitrogen and other polluters from all animal manures, liquid fertilizer and chemical fertilizers must not be allowed to mix with and leak to surface or underground water sources. In other words a leakproof storing facility with proper qualifications and dimensions must be constructed in those enterprises or animal manure must be transported safely to a place to be stored. Also there must be leakproof transfer systems between shelters and fertilizer stores.

The following subjects must be followed for the sustainable management of all animal manure (solid and liquid) in an enterprise:

1. rainwater flows in open fertilizer storing areas, fertilizer gathering grounds, barns or loading areas related to stock management and areas for keeping the animals,
2. washing water coming from milking sheds, other animal shelters (animal ranges) and storage facilities,
3. leaks and flows coming from animal manure stores,
4. leaks and waste coming from silage and other animal fodder stores Good Agricultural Applications Code).

If there is a need for a new or more developed storing facility, design and construction of that facility must comply with the standards defined by Ministry of Agriculture and Forestry or any other official body that has the authority to give license to the facility. These standards include legal obligations, planning controls, construction standards, pollution control, health and safety standards and etc. All the construction and manufacturing must comply with Turkish standards, existing legislation and general technical specifications published by Construction Works Directorate of Ministry of Environment and Urbanization. The concrete used in the construction must be high quality like C25/30-SRC (sulphate resistant cement) (Good Agricultural Applications Code)

The aim of this sustainable management is minimizing the pollution risks and distributing the animal manure with ease by building a store or a pit. Following subjects must be calculated and considered before determining the animal manure storage capacity (Table 3 and 4):

1. The time period when animal manure cannot be applied to the soil for any particular reason,
2. Type and number of animals,
3. Amount of animal manure
4. Any roof area that rainwater may be drained away or emptied to yard,
5. Any yard area that dirty water can assembly,
6. Expected rainfall during the time of storage
7. Amount of water used for cleaning the milking shed or other facilities (Good Agricultural Applications Code).

There must be 200mm and 300 mm freeboard at closed and open stores respectively. Net rainfall along the duration of storage must be considered and evaluated for the open storage facilities (Good Agricultural Applications Code).

Solid animal manure stores must be covered with a roof or a polyethylene cover in order to prevent rain washing. It also helps excessive flow and water leakage. Additionally, it increases the value of the animal manure as it reduces the risk of contamination. Besides, the animal manure storage facility should be designed and constructed with the least possible leakage to surface and underground water sources and minimizing the air pollution **(**Atılgan ve ark., 2013).

Table 3. Cattle, Sheep and Poultry; Liquid Manure (Slurry) Amounts

Type of Animal	m^3/week
Dairy cattle (6000 L/year milk)	0,33
Dairy cattle (3000 L/year milk)	0,29
Cattle>2 years	0,26
Cattle (18-24 months)	0,26
Cattle(12-18 months)	0,15
Cattle(6-12 months)	0,15
Cattle(0-6 months)	0,08
Goat	0,02
Sheep	0,03
Lamb	0,01
Poultry – 1000 animals (30% dry material)	0,81

Table 4. Manure Amounts To Be Considered For Determining The Storage Capacity

Type of Animal	Solid rate ($m^3 \cdot week^{-1}$)	Liquid rate ($m^3 \cdot week^{-1}$)
Dairy cattle (6000 L/year milk)	0.28	0.04
Dairy cattle (3000 L/year milk)	0.25	0.03
Cattle>2 years	0.23	0.02
Cattle (18-24 months)	0.23	0.02
Cattle(12-18 months)	0.13	0.01
Cattle(6-12 months)	0.13	0.01
Cattle(0-6 months)	0.07	0.01

Since, limiting the water waste means saving on the water costs, transferring liquid animal manure and waste will cost less by using less washing water. Disturbing smells and ammonia loss decreases with the decrease in manure production due to less water use, ending up with more valuable manures.

The new facilities to be established should be constructed considering the predominant wind direction and the distances given in Table 5**.**

Table 5. Distances between manure storage and other facilities

Unit	Distances	
	Open Manure Yard	Roofed Manure Store
House	20 m	10 m
Neighbor	30 m	20 m
Production-Process Facility	50 m	20 m
Seed-Fodder Storage	10 m	5 m
Well	15 m	15 m
Water Sources	50 m	50 m

An evaluation is made about the presence of facilities and storage capacities for animal manure, silage waste water and rainfall water, for sustainable management of animal manures or other organiz fertilizers.

However, in the application of all animal manures and other fertilizers of organic origin on farms, the flow of fertilizer waste to surface water or leakage into surface water should be prevented with farmland management.

In this context, farmers who have a sufficiently incomed agricultural land size in Regions Sensitive to Nitrate should prepare the fertilization plan for the application of nitrogen from animal and chemical fertilizers for each plant variety before planting or planting (Yoldaş et al., 2017; Ceylan et al., 2017; Yoldas et al., 2008; Ceylan et al., 2004). The amount of fertilizer to be applied to the soil must certainly be determined by conducting a soil analysis. In soils that receive high levels of precipitation or irrigation, fertilizers containing nitrogen in the form of nitrates should be divided and applied, as the risk of washing is high. Fertilizer applications on lands with a slope exceeding 20% should only be carried out provided that special measures (terracing, permanent vegetation, etc.) are taken. Nitrogen fertilizer should be applied by dividing them in appropriate amounts during the growing season. With the application of forecasting and warning systems, the economic threshold value should be determined as a result of the density, biology and plant phenology of diseases and pests, and plant protection products should be applied whenever necessary. Because, Good Agricultural Practices Code includes provisions regarding land management, plant nutrient management, animal manure management, irrigation management, plant protection products management and records that should be kept in operation for the prevention of nitrate pollution from agricultural activities in waters (Anonymous, 2021b).

Animal and chemical fertilizers should not be applied if the soil surface is bare and lacks vegetation outside the planting period. Grasslands should not be plowed where it is sloping and there is a high risk of erosion, if they need to be plowed, they should be driven in the spring and then plants with high nitrogen needs should be planted. Appropriate techniques should be used in the management of saline-alkaline and acidic soils. Measures to be taken for surface flow and erosion control; critical slope values should be determined by taking into account precipitation, vegetation and texture. The planning of crop rotation should be carried out by taking the production pattern suitable for the regions into account. Instead of burning stubble residues, tools and equipment that break down the stubble residues should be used.

In this context, when animal manure or chemical fertilizers are applied while the soil surface is bare and lacking vegetation, or when the plants have not covered the soil surface, nitrate leaks down with the effect of gravity and water, moves away from the root zone and mixes into the underground waters without being taken by the plants. The amount of nitrates lost by leakage varies depending on the type of fertilizer, the amount of precipitation, the structure of the soil and the plant pattern at that time.

In addition, a proper crop rotation and green fertilization planning should be carried out to ensure optimum use of labor and equipment, to provide maximum biological benefit from alternative weed killers by taking the competition in control of foreign weeds into account, to take measures for weeds in order to reduce diseases, to include legumes, which are biological sources of nitrogen, where the soil needs it.

With sustainable soil and pasture management, the deterioration of soils and pastures should be prevented, the increase of production and restructuring of agricultural operation activities by planning income-generating products should be ensured.

In order to ensure fertile pastures and prevent soil erosion, animal manure management under suitable conditions should be combined with pasture and agricultural management.

A healthy and productive livestock requires enough space, feed and water. For this purpose, the capacity of fertilizer storage should be determined and grazing areas of animals and the necessary complements should be provided. Animals can be collected near the water source, in areas where feeding is carried out and in shaded areas. In these cases, there is a possibility of excessive accumulation of animal manure. These problems can be reduced by properly determining the animal density and rest areas in the unit area and planning irrigation units to prevent direct contact between water sources and animals (Atılgan et al., 2011).

Overgrazing, unnecessary soil processing and burning of plant residue on the soil surface can pose a risk of the destruction of soil organic matter and decreased soil aggregate stability. It should be taken into account that excessive irrigation and fertilization is an element that reduces

yield by increasing salinity in the soil and damaging soil quality. Measures such as conservation tillage and anti-erosion should be taken, integrated management strategies should be implemented to reduce N loss from soil: making chemical and animal manure applications that contains nitrogen at the right time, using and developing soil, water, plant and animal manure analysis methods for determining nitrogen available periodically better, switching to more effective nitrogen fertilizer application and recommendation methods, ensuring greater adoption of plant nutrient management plan, dissemination of Nitrification and the use of urea inhibitors, nitrogen fertilizer in accordance with the local environment and soil conditions (Anonymous, 2021c).

On the other hand, about the risk management in agricultural production; all kinds of technical, cultural and biological measures should be taken during the production phase. In order to remove the effects of structural problems that are an obstacle to the disposal of productivity in agricultural production the need to complete agricultural infrastructure works, especially land consolidation, in addition to the necessary legal regulations, continues (Anonymous, 2021a).

In this context, according to the data of the Provincial Directorate of Agriculture and Forestry, it is clear that 90% of the existing livestock enterprises in the province are inadequate in terms of cultural technical infrastructure, agrotechnics and technologies that do not cause nitrate pollution in the waters. Therefore, it should not be ignored that the fact that it is only possible to keep up with the sustainable new world order only by the joint action of all stakeholders in the sector and by working side by side, shoulder to shoulder.

As a result, the "Good Agricultural Practices Code", which is a sustainable agricultural method against nitrate pollution in waters, will contribute to the solution of the above-mentioned problems, but also contribute to the lack of nitrate sensitive areas and affect the prices of agricultural products offered to the domestic and international markets, thus will increase the competitiveness of the sector and ensure the positive development.

CONCLUSIONS AND RECOMMENDATIONS

The importance of animal food in terms of human nutrition and health can never be underestimated. Therefore, depending on the growing population, it is necessary to consider the increase in the number of animals and the increase of animal products naturally. Nevertheless, living healthy and the protection of nature are as important as multiplying food sources. In this regard, by systematically implementing sustainability in livestock, rural development will be achieved through engineering advances in one area and development in the other field, namely socio-economy and ecology.

In our province, two important problems arise due to the increase in livestock presence. The first is the mixing of contaminants into surface water by surface flow and into underground water by deep leakage due to wastes generated in barns, and the second is that waste on the land is transported from barns for the evaluation of liquid and solid fertilizers elsewhere **(Varol and Atılgan, 2017)**.

Because wastes that cause environmental problems in livestock enterprises are also an important economic potential. Animal-derived wastes are evaluated in different ways (biogas energy, etc.) and are generally used as fertilizers in vegetable production. In this context, a pilot animal manure management infrastructure model should be planned to be established by the public in accordance with nature. Thus, a sustainable "implementation project" will be carried out by the public and an environment of improvement and awareness in fertilizer production will be provided for farmers and businesses (Çardakçı et. al., 2020). Thanks to the improvement to be carried out with this innovation, fertilizer management optimization can be achieved and thus these inert wastes will be considered as economic resources, as well as reducing environmental pressure.

The area where the investment of this innovative pilot fertilizer management infrastructure model will be made should be determined on a basin basis as "Innovative Research Application and Production Farm" that should be accessible to all actors. As a matter of fact, this farm will have the ability to provide publication and applied trainings for nitrate pollution management in the waters to agricultural engineers, veterinarians and all interested parties, especially producers, and to provide the basis for innovation in a regional and regional perspective for R&D studies to be carried out on the subject. The main goal here is to show that in agricultural enterprises, with the purpose-built warehouse, the risk of contamination is reduced and fertilizer management is streamlined. (Çardakçı et. al., 2020). Thus, significant benefits can be provided to the economy of our province with the use of inputs with high added value content in the livestock sector and the contribution it will make to the manpower trained in this field.

Moreover, sustainable spatial strategic plan (design) and analyzes should be made by the public for the management of nitrate pollution in waters originating from livestock, to be made in the basin, which has the feature of being a pilot, by using the Geographical Information System (GIS) technologies of the location and distribution of the problems of the location and distribution of livestock enterprises in the rural area (Alkan et al., 2012)**.** Because the data and maps to be obtained from this sustainable spatial strategic plan can be used as a basis for legislation and zoning applications to be made by the authorized bodies for rural planning. By this means, livestock enterprises will be able to contribute to the creation of sustainable rural areas that enable clean production in a way that does not create nitrate pollution in the waters and with sustainable strategic plan and report on the axis of regional development.

It is possible to provide the expected benefits from the culturaltechnical projects it enters in animal fertilizer infrastructure with sufficient emphasis on agrotechnical and vegetative measures on agricultural land as well as engineering services. Physical planning for the solution of physical problems in livestock can be achieved with a great weight of engineering knowledge and technical studies based on agricultural culture in this scope. The number of technical personnel with such technical knowledge, which can be summarized with the term culturaltechnical engineering, is still small in our country. For this reason, there is a need to establish investment institutions that aim to train and employ technical personnel who can use this kind of technical knowledge with all legal engineering authority.

Ultimately, thanks to aforementioned the pilot feature of the institution investment of agriculture model that is ecological, innovative, technological and sustainable to be made by the public hand, it will become an exemplary agricultural technology innovation center by creating a butterfly effect to digital transformation in agriculture. Thus, faced with productivity and market pressures around the world, the livestock sector will have the new tools it needs to maintain competitiveness and increase their capacity for innovation and sustainable agricultural practice.

REFERENCES

1. Aksu, C. (2012). *Sürdürülebilir Kalkınma ve Çevre, Güney Ege Kalkınma Ajansı*.
2. Alkan, İ., Yılmaz, H.İ., Ünal, H.B. (2012). *Gübre Yönetiminde Karar Destek Sistemlerinin Kullanılması,* II. Ulusal Sulama ve Tarımsal Yapılar Sempozyumu, vol.1, pp.329-335, İzmir, Turkey.
3. Anonim. (2021a). https://www.sbb.gov.tr/wpcontent/uploads/2020/06/Tar%C4%B1mda-Toprak-ve-Suyun S%C3%BCrd%C3%BCr%C3%BClebilir-Kullan%C4%B1m%C4%B1-%C3%96zel-%C4%B0htisas-Komisyonu-Raporu.pdf).
4. Anonim. (2021b). https://www.gidahatti.com/sularda-kirlenmeye-karsi-iyi-tarim-uygulamalari-kodu-75522/.
5. Anonim.(2021c). https://tekirdag.tarimorman.gov.tr/Belgeler/2017/%C4%B0Y%C4%B0%20TARIM%20 UYGULAMALARI %20KODU.pdf).

6. Anonymous. (2018). *İş Dünyası ve Sürdürülebilir Kalkınma Derneği*, 2018. Sürdürülebilir Tarım İlkeleri İyi Uygulama Rehberi, İstanbul
7. Arıcı, İ., Yaslıoğlu, E. (2009). *Kırsal Yerleşim Tekniği*, U.Ü. Ziraat Fakültesi Ders Notları No:104, Bursa.
8. Atılgan, A., Coşkan, A., Öz, H. (2013). *Management of Manure from Livestock Housing and Its Enviromental Potential Impact on Water Resources*. The 20th International Symposium on Plant Irrigation, Bydgoszcz, Poland, 19 - 21 June, 2013, pp.1
9. Atılgan, A., Öz, H., Büyüktaş, K. (2011). *The location of manure accumulated in cattle livestock barns and its interaction with the environment*, Afrıcan Journal of Bıotechnology, vol.10, no.77, pp.17825-17830, (Journal Indexed in SCI)
10. Atılgan, A., Öz, H., Karaca, C., Erkan, M.C. (2012). *Hayvan Barınaklarında Oluşan Gübrenin İşletimi ve Depolanması İçin Mevcut Yasal Düzenlemeler*, II. Ulusal Sulama ve Tarımsal Yapılar Kongresi, pp.891-899, İzmir, Turkey.
11. Atılgan, İ. (2000). *Türkiye'nin enerji potansiyeline bakış*. Gazi Üniv. Müh. Fak. Der., 15, 1, 31-47
12. Aydın, M., Şeref, K. (2013). *Toprak Bilimi*, Nobel Akademik Yayıncılık, 2. Basım, Ankara.
13. Banger, G. (2016). *Endüstri 4.0 ve Akıllı İşletme*, Dorlion Yayınları, Ankara.
14. Benzer, R., Benzer, S. (2018). *Forecasting the Nitrate Pollution of Groundwater and Surface Waters: Kütahya Example*, Karaelmas Science and Engineering Journal, Volume: 8, Issue 1, Zonguldak.
15. Bilge, A.C., Çinko, M.A., Eyüpgiller, K.K., Eres, Z.M. (2017). *Kırsal Mimarlık Mirasının Korunması Türkiye'den ve Dünyadan Örnekler*, Arkeoloji ve Sanat Yayınları, İstanbul
16. Brohi, A.R., Karaman M.R., Müftüoğlu, N.M., Öztaş, T., Zengin, M. (2012). *Sürdürülebilir Toprak Verimliliği,* Koyulhisar Ziraat Odası Kültür Yayınları No:1, Çorum.
17. Çardakçı, Y. (2020). *Küçük Menderes Havzası Sularında Büyükbaş Hayvancılık Kaynaklı Nitrat Kirliliğinin Good Agricultural Applications Codena Göre Sürdürülebilirlik Analizi ve Hayvansal Gübre Yönetiminde İnovatif Bir Fizibilite Örneği*, Yüksek Lisans Projesi, Sürdürülebilir Tarım ve Gıda Sistemleri Ana Bilim Dalı, Fen Bilimleri Enstitüsü, İzmir
18. Çayır, M., Atılgan, A., Öz, H. (2012). *Büyükbaş Hayvan Barınaklarındaki Gübrelikler ve Su Kaynaklarına Olan Durumlarının İncelenmesi,* Süleyman Demirel Üniversitesi Ziraat Fakültesi Dergisi 7 (2):1-9
19. Ceylan Ş., Yoldaş, F., Saatçı Mordoğan, N., Tepecik, M. (2017). *Effects of different doses of organic fertilizer on nitrate accumulation and some nutrient element content of lettuce,* Acta Biologica Turcica, vol.30, no.4, pp.164-168, (Refereed Journals of Other Institutions)
20. Ceylan, Ş., Saatçı Mordoğan, N., Çakıcı, H., Yoldaş, F. (2004). *Effects of Different Nitrogen Levels on The Yield and Nitrojen Accumulation in The Rocke*t, Journal of Balkan Ecology, vol.1, pp.42-45, (Refereed Journals of Other Institutions)
21. Emiroğlu, A. (2018). *İnovasyon ve Teknoloji Yönetimi*, 1. Baskı, Ekin Kitabevi, Bursa.
22. Erkek, D. (2011). *Ar-ge, İnovasyon ve Türkiye Neredeyiz?* T.C. Güney Ege Kalkınma Ajansı (GEKA), Denizli, 2011.
23. Eylem Polat, H., Olgun, M. (2009*). Hayvancılık İşletmelerindeki Atık Yönetimi Uygulamalarının Su Kirliliği Üzerine Etkileri,* GOÜ. Ziraat Fakültesi Dergisi, 26(2), 71-80
24. Karaca, M., Yıldız, Y. (2010). *Hayvan Barınaklarının Çevre Denetimi*, Hasat Yayıncılık, İstanbul
25. Karacan, A.R. (2007). *Çevre Ekonomisi ve Politikası*, E.Ü. İktisadi ve İdari Bilimler Fakültesi Yayın No:6, İzmir.

26. Liftin, K.T., Çeviren: Ercan, P. (2014). *Eko Köyler*, Alfa Basım Yayım, İstanbul
27. Olgun, M. (2011). *Tarımsal Yapılar,* A.Ü Ziraat Fakültesi Yayın No:1577, Ders Kitabı:529, Ankara
28. Ozturk, I., Ünal, H.B. (2011). *Evaluation of Manure Management in Dairy Cattle Farms: The Case of Izmir-Tire (Turkey) Region,* Kafkas Üniversitesi Veteriner Fakültesi Dergisi,,vol.17, no.5, pp.741-747, 2011 (Journal Indexed in SCI).
29. Pezikoğlı F. (2006). *Türkiye'de Südürülebilir Tarım Uygulamalrı ve Yönlendirilmesi için Gerekli Politikaların Belirlenmesi,* Doktora Tezi, Tarım Ekonomisi Ana Bilim Dalı, Uludağ Üniversitesi Fen Bilimleri Enstitüsü, Bursa.
30. Turhan, Ş. (2005). "*Tarımda Sürdürülebilirlik ve Organik Tarım",* Tarım Ekonomisi Dergisi, 11(1): 13–24.
31. Varol, H., Atılgan, A. (2017). *Hayvancılık İşletmelerinde Oluşan Atıkların İşletimi ve Olası Çevre Etkileri: Afyonkarahisar Örneği,* Akademia Mühendislik ve Fen Bilimleri Dergisi, Cilt 1, Sayı 3, Sayfalar 211-221 (Diğer Kurumların Hakemli Dergileri).
32. Yoldas, F., Ceylan, S., Yağmur, B., Mordoğan, N. (2008*). Effects of nitrogen fertilizer on yield quality and nutrient content in broccoli*. Journal of Plant Nutrition, 31(7), pp.1333-1343.
33. Yoldaş F., Ceylan Ş., Mordogan N., Esetlili B.C. (2011). *Effect of organic and inorganic fertilizers on yield and mineral content of onion (Allium cepa L.).* African Journal of Biotechnology Vol.10 (55), ss.11488-11492, 2011.

Corresponding Author: Funda YOLDAS
Adres: Ege Üniversitesi Ödemiş Meslek Yüksekokulu, Ödemiş,
İzmir, Turkey,
Phone: +90(542)3225385
e-mail: funda.yoldas@ege.edu.tr
OrcID:: 0000-0001-6205-9751

Received: 1 December 2021
Revised: 16 March 2022
Accepted: 15 May 2022