MEDWELL PUBLISHING
Journal of Animal and Veterinary Advances 8 (5): 843-852, 2009
ISSN: 1680-5593
© Medwell Journals, 2009

Economics of Manure use as Fertilizer in Crop Production Engaged also in Beef Cattle Farms in Turkey

[1]Hasan Yilmaz, [2]Hayati Koknaroglu and [1]Vecdi Demircan
[1]Department of Agricultural Economics, [2]Department of Animal Science,
Suleyman Demirel University, Isparta, Turkey

Abstract: Aim of the study, was to analyze economics of manure use for different size and to try to establish a budget for plant nutrient demands and in addition to show how much fertilizer could be saved by introducing manure as fertilizer in beef cattle farms engaged also in crop production in Afyon province in Turkey. Data were obtained by conducting a questionnaire with 100 beef cattle farms selected by stratified random sampling method and of these farms 77, which had beef cattle and crop production were analyzed. Considering animal population of farms and frequency distribution, farms were divided into 3 groups. Accordingly farms were classified as: Group I, farms that have 5-10 animals (27 farms), Group II, farms that have 11-25 animals (28 farms) and Group III, farms that have >25 animals (22 farms). It was found that as farm size increased ratio of crop nutrient demand met by manure increased. Crop nutrient demand met by manure was 22.0, 43.0 and 93.6% for Group I, II and III, respectively. When, farmers used manure as fertilizer, amount of saving were 30.6, 71.1 and 142.4 YTL ha^{-1} for Group I, II and III, respectively (1USD = 1.34 YTL). These results indicate that dependence of farmers to chemical fertilizers will be reduced and manure use will become economical for farmers. In addition, effective manure and chemical fertilizer management will minimize environmental pollution thus, aiding to sustainable agriculture.

Key words: Manure, chemical fertilizer, economics, crop production, beef cattle, Turkey

INTRODUCTION

Turkey is located between Europe and Asia and is unique for having a large and sustainable agricultural sector. It is also, one of the richest and largest countries in terms of land: Almost 16% of the country's land area consists of meadows and pastures, whereas 26% is covered with forest and woodland and 31% is arable lands (FAO, 2004). Because of its suitable land and climate, Turkey has a great capacity to grow many kinds of crops and animals.

In Turkey, on the other hand, livestock sector has a considerable potential and is an important part of agricultural sector and economy. Animal husbandry constituted approximately 25% of agricultural production value (SIS, 2003).

Livestock products are an important source of household income for many farmers and households in rural areas. In Turkey, the family owned farm is the basic unit of agricultural production and family members provide most of the farm labor.

Statistics revealed that 30.21% of all farms were engaged only in crop production and 67.43% of all engaged in crop production and animal husbandry, while the reminder 2.36% were engaged only on animal production (SIS, 2004).

Manure's richness in plant nutrients has made it appealing as a fertilizer in crop production since the beginning of agriculture (Unterschultz and Jeffrey, 2001). Manure is a source of major plant nutrients such as nitrogen, phosphorus and potassium and the secondary nutrients that plants require. On the other hand, the benefit of recycling manure is to supply nitrogen for plant production (Jokela, 1992). The appropriate use of this available commodity can reduce the need for mineral fertilizer (Tanksley and Martin, 2003), thereby creating an economic incentive for use.

Also, using manure as fertilizers provides financial savings through less use of commercial fertilizer and manure is a viable biological resource to be utilized on cropland (Thompson *et al*., 1997; Araji *et al*., 2001). Costs of using manure as a fertilizer includes loading, hauling, spreading and incurred pollution expenses (Freeze *et al*., 1993). These costs are normally less than the farmer's benefit from manure use. The environmental benefit includes saving fossil fuel reserves, which is used in the production of fertilizers (Peterson and Russelle, 1991).

Corresponding Author: Hasan Yilmaz, Department of Agricultural Economics, Faculty of Agriculture, Suleyman Demirel University, Isparta, Turkey

The subsidy-backed price policy for fertilizer has often been blamed for non-transparency, indiscriminate and irrational use but the correction of domestic price distortions is not the remedy of the environmental threat, as market prices and increased competition of the free trade regime could also intensify resource use in the search for higher productivity from soil (Yilmaz, 2003). The fertilizer market was greatly promoted by the government as well as by commercial enterprise in Turkey but rural manure market remained limited, unorganized and local (WB, 2004).

In Turkey, yearly amount of available manure obtained from the current animal population (cow, sheep and poultry) was around 13.3 million tons and of these 10.6 million tons of available manure were obtained from 12.9 millions cattle (LIFE, 2005). Turkey is one of the few countries that burn dry manure for heating. In Turkey, approximately 55% of the manure produced is burned for heating and only 5.5% is used as fertilizer and this problem still keeps its importance (Kacar, 1997). In order to increase manure use in rural areas, legislation prohibiting usage and incentive policies for alternative heating sources for rural areas should be developed and farmers should be given information on farm yard manure called organic fertilizer positively affecting agricultural production (Sayin *et al*., 2005).

Chemical fertilizers make an important contribution to agricultural productivity and increase the agricultural production because of their high nutrient content effects on crops in a short time (Eyupoglu, 2002). The balanced and sufficient amounts of fertilizer application are very important for the stability of productivity and its improvement. Since, energy price increases, fertilizer production costs also increases thus, increase in price of commercial fertilizer has heightened interest in the use of livestock manure for supplying crop nutrients and has significantly increased the value of manure as a nutrient source (Yilmaz, 2003).

In Turkey, during years 1999-2001, use of manure as natural fertilizer declined by 3-4%, roughly in proportion to crop production.

The declining amount of manure used probably reflects the declining number of animals, but as chemical fertilizer prices have risen sharply, some farmers are likely substituting manure used for fuel (heating) for field use. This substitution has therefore, moderated manure usage for fertilizer despite the large drop off in herd sizes and manure availability (WB, 2004).

The objective of this study, was to compare economics of manure use as fertilizer from different beef cattle farm sizes and to try to establish a budget for plant nutrient demands and in addition to show how much fertilizer could be saved by introducing manure as fertilizer in farms combining crop and animal production.

MATERIALS AND METHODS

Characteristics of the study area: The study area, Afyon, is located in Interior Anatolian sub-region of Aegean region. Afyon is in mountainous countryside inland from the Aegean coast, having area of 14.300 km^2 (Anonymous, 2004) Afyon is under influence of continental climate thus, winters are cold and snowy and summers are hot and dry and has elevation of 1034 m. Average precipitation is 458 mm and most of which, occur during winter and spring season and average relative humidity is 59% (Anonymous, 2004).

Since, Afyon does not have pastures, most of the cattle production takes place in feedlot. In Afyon, farmers are generally involved in crop production and animal husbandry. Statistics revealed that 29.6% of all farms were engaged only in crop production and 68.2% of all engaged in crop production and animal husbandry, while the reminder 2.2% were engaged only on animal production (SIS, 2004).

Beef cattle production is an important branch of animal agriculture in Afyon and is ranked as 3rd in the country. Red meat production in Afyon was 19 118 tons and 96% of it came from beef. There were total of 210, 043 cattle in Afyon and 76% of these cattle were continental European breeds (SIS, 2005). Afyon is an intersection between larger cities and provides meat products to these cities. Thus, as a result of this there is an industry based on beef production in Afyon (SPO, 1996a).

In Afyon, 176, 053 tons of available dry manure was obtained from cattle (LIFE, 2005). In the study area, manure is stored as piles and after the manure dries it is transported to the field to be mixed to soil. Of the farms investigated, only 15.6% had manure pit and rest (84.4%) stored manures as piles outside of the barns. In Afyon, most of the manure produced was used in crop production and it was observed that there were no measures to mature the manure to use in crop production. Face to face interviews with farmers revealed that farmers were not aware how to store manure and how to know manure application procedure to field. Since, manures are stored as piles in outside, the odor spreading causes environmental pollution.

Methods and data: Most of the farms in this area are classified as family farms and the main economic activity is beef production. Districts chosen for research purpose constituted 81.7% of beef cattle population in Afyon

province (Anonymous, 2004) and thus, sample size represents population size. The survey was conducted in August 2005 on 100 beef cattle farms located in 23 villages of 6 districts of Afyon province, namely. Bolvadin, Suhut, Cay, Dinar, Sinanpasa and Ihsaniye. The data were derived from beef farms with a questionnaire addressed to farmers. The questionnaire was carried out with face to face conversation with farmers. Among invested farms 23 had only beef production, 77 had beef production and crop production. Thus, for the aim of this study only 77 farms were chosen for analyses. Neyman method of stratified random sampling method was conducted to select number of beef cattle farms for questionnaire (Yamane, 2001). Sampling size was determined by using Eq. 1. The permissible error was defined to be 5% for 95% reliability.

$$n = \frac{N\sum N_h S_h^2}{N^2D^2 + \sum N_h S_h^2} \quad (1)$$

where:

n = Sampling size
N_h = Number of farms in hth group
S_h = Standard deviation of hth group
S_h^2 = Variance of hth group
N = Population size
D^2 = Is $(d/z)^2$

Farms that questionnaire conducted were randomly chosen. Since, there were differences in cattle population among farms, establishment of groups were decided to homogenize population. Considering animal population of farms and frequency distribution, farms were divided into 3 groups. In distributing farms to groups Eq. 2 was used (Yamane, 2001). Thus, farms were classified as: Group I: farms having 5-10 animals (27 farms), Group II: farms having 11-25 animals (28 farms) and Group III farms having >25 animals (22 farms).

$$n_h = \frac{N_h S_h}{\sum N_h S_h} \times n \quad (2)$$

where:

n_h = Sampling size for each group
n = Sampling size

The actual nutrient content of manure varies with age, type and size of animal; the composition of the feed ration; the rate of feed consumption and its moisture content (Adhikari *et al*., 2005).

As nutrient content of manure, it was assumed that manure would have 79% moisture and 21% dry matter. Of the dry matter 1.17% was N, 0.88% P_2O_5 and 0.83% K_2O (Kacar, 1997).

For determining economics of manure and fertilizer use, chemical fertilizers and manure amount spread by farmers for each particular crop was recorded.

In determining nutrient demands of crops, results obtained from fertilizer experiment in the region by Research Institute of Soil and Fertilizer of General Directorate of Agricultural Research were used and suggested fertilizer amounts were considered (MARA, 2006).

RESULTS AND DISCUSSION

General characteristics of the farms: The average crop area of the investigated farms was 5.4 ha. The average household size was 4.8 people. The average family size in the research sample was lower than the average family size (5.4 people) in the rural regions of Turkey (SPO, 1993). The average age of the farmers was 45.8 years and average experience of farmers in agriculture was 18.3 years. It was found that, on a total, 3.5 h day^{-1} was spent on agricultural activities. Results demonstrated that 2.6% of the farmers were illiterate, 54.5, 19.5 and 23.4% were primary school, middle school and high school or university graduates, respectively (Table 1).

The average number of beef cattle in the investigated farms was 19.7 head. The average quantity of available manure was 22.9 tons (Table 1).

Forages were the major crops (59.5%) in the investigated farms, followed by wheat (20%), potatoes (9.6%), sugar beets (8.3%), poppy (1.2%), other vegetables (1%) and sunflower (0.5%).

Table 1: General characteristics of the farms

General characteristics	Values
Crop area (ha)	5.4±6.20[a]
Farmers age (year)	45.8±11.2
Farmers' experience in agriculture (year)	18.3±8.60
Number of persons in family (person)	4.8±1.60
Total working hours (h daily^{-1})	3.5±1.40
Beef cattle (head)	19.7±14.9
Number of days cattle fed (days)	207.4±75.9
Available manure (tons)	22.9±19.5
Education level (number)	
Illiterate	2.0 (2.6[b])
Primary school	42.0 (54.5)
Middle school	15.0 (19.5)
High school or university	18.0 (23.4)
Cropping system (ha)	
Wheat	83.5(20.0[b])
Potatoes	40.2 (9.6)
Sugar beets	34.8 (8.3)
Sunflower	2.0 (0.5)
Poppy	5.2 (1.2)
Vegetables (bean fresh, okra, green pepper)	4.1 (1.0)
Forage production area (ha)	248.6 (59.5)
Total farm area (ha)	418.1 (100)
Feed source supplied on-farm (%)	30.9
Feed source supplied off-farm (%)	69.1

[a]Standard deviation, [b]Percent

Table 2: Annual quantity of manure and available manure by farm groups

Groups	Number of farm	Number of cattle, head	Manure production per cattle (tons)	Total amount of manure (tons)	Available manure (tons)[a]
I (5-10 cows)	27	196	5.0	979.0	205.6
II (11-25 cows)	28	476	5.5	2,635.5	553.4
III (>25 cows)	22	846	5.7	4,780.8	1,004.0
Total	77	1,518	5.5	8,395.3	1,763.0

[a]Assumed 79% moisture and 21% dry matter

As a result of having beef cattle production, farmers included forage and grain production in their farms. Total forage production area was 248.6 ha (Table 1). Since, pastures in the study areas are in low quality, this caused cattle feeding based on manufactured concentrate mixes that are expensive. As a result of this malnutrition of cattle an increase in production costs was observed. Considering this situation forage production area should be increased for good quality of roughage. Ratio of feed supplied by farm operations was 30.9% (Table 1).

Annual quantity of manure: Annual quantity of feedlot manure and available manure are given in Table 2. In the farms investigated there were 1518 beef cattle in 77 farms and total amount of manure produced was 8 395.3 tons and manure amount in terms of dry matter was 1 763 tons. Amount of manure produced by cattle in the investigated farm for the duration of feeding period (207.4 days) was 5.5 tons, whereas, this amount was 9.9 tons/cattle/year for Turkey (LIFE, 2005).

Manure application and crop demands: Crop nutrient demand supplied by manure and fertilizer application by farm groups is provided in Table 3. Determination of using manure as a plant nutrient source for complementing crops demands were analyzed by applying animal manure based on the recommended rates of nitrogen, phosphorus and potash for each crop (MARA, 2006).

Soil in Turkey is poor in nitrogen and phosphorus and is rich in potassium. Thus, plant nutrients needed for fertilization are nitrogen and phosphorus. Compared to nitrogen and phosphorus containing fertilizers, need for potassium containing fertilizers is minimal thus, little amount of potassium containing fertilizers are applied (Eyupoglu, 2002). Potassium demand of some crops in Table 3 is reported as zero. The reason fort his is that soil was rich in potassium and there was no need to apply potassium containing fertilizers. However, some crops demanded more potassium than soil provided thus, additional potassium containing fertilizers had to be applied for these crops at recommended dose (Table 3).

For good quality and high yield soil should be rich in organic matter. Organic matter content of soils in Turkey is generally low (GDRS, 1995). Manure is an important organic matter source and thus, manure use in Turkey becomes more important.

Since, manure does not meet crop nutrient demand, chemical fertilizers should be used to supply nutrients deficient in manure. Manure presents a special problem because the nitrogen-to-phosphorus ratio in manures is lower than that needed by crops (Risse *et al*., 2001). The reason why farmers prefer chemical fertilizers is the variability and uncertainty concerning manure nutrient availability. Chemical fertilizers can be given together to meet the exact multi-nutrient demands of crops. However, this type of nutrient flexibility is not available with manure, particularly when managers try to meet all the crop demands (Olson and Paterson, 2005). When meeting one nutrient of crop by manure application other nutrients might be over or under applied. In spite of its practical shortcomings relative to modern agricultural chemicals, manure is an excellent organic soil amendment that is available on the farm. It is a source of nutrients that can improve soil tilth and structure (Unterschultz and Jeffrey, 2001).

Total crop area for Group I, II and III was 130.0, 151.5 and 136.6 ha, respectively (Table 3). Percentage of forage production area in total crop area was 64.9, 46.7 and 68.4% for Group I, II and III, respectively.

Crop area, crop nutrient demand and nutrient supply from manure and chemical fertilizers by farm groups are given in Table 3. Ratio of crop nitrogen demand met by manure in Group I, II and III were 23.1, 44.8 and 102.3%, respectively. In Group III manure application provided more nitrogen than crop nitrogen demand. Ratio of crop phosphorus demand met by manure in Group I, II and III were 8, 17.1 and 34%, respectively. In all farm groups potash amount exceeding crop nutrient demand was provided by manure. As for average for all farm groups 56.7% of nitrogen and 20.1% phosphorus demand of crops were met by manure.

Economic loss and saving due to fertilizer and manure use: Economic loss due to fertilizer and manure use in the investigated farmers are given in Table 4. As the farms size increased, ratio to meet total crop nutrient demand by

Table 3: Crop area, nutrient demand, nutrient supply from manure and fertilizer by farm groups

Cropping system	Crop area (ha)	Crop nutrient demand (kg)		
		N	P	K
Group I				
Wheat	27.5	2,200	2,200	0
Barley	50.1	3,507	3,507	0
Potatoes	5.7	798	570	513
Alfalfa	5.0	200	650	0
Maize	7.7	1,232	539	0
Sainfoin	0.3	9	18	0
Cow vetches	19.6	784	1372	0
Sugar beets	5.4	918	486	0
Fodder beet	1.7	136	119	0
Chick peas	0.2	8	12	0
Sunflower	2.0	200	140	0
Poppy	3.1	217	155	0
Other vegetables (bean fresh, okra, green pepper)	1.7	221	119	119
Group's total crop area	130.0	-	-	-
Group's total forage production area	84.4	-	-	-
Total crop nutrient demands	-	10,430	9,887	632
Nutrients supplied by manure from 196 beef cattle	-	2,405	790	1,422
Ratio to meet crop nutrient demand by manure (%)	-	23.1	8.0	-
Nutrient supplied by fertilizer (kg)	-	9,482	3,321	113
Group II	-	-	-	-
Wheat	34.4	2,792	2,792	0
Barley	36.3	2,538	2,538	0
Potatoes	21.5	3,010	2,150	1935
Alfalfa	6.8	272	884	0
Maize	2.7	432	189	0
Rye	3.0	210	210	0
Cow vetches	14.3	572	1,001	0
Sugar beets	21.9	3,723	1,971	0
Fodder beet	7.7	616	539	0
Poppy	1.5	105	75	0
Other vegetables (bean fresh, okra, green pepper)	1.4	182	98	98
Group's total crop area	151.5	-	-	-
Group's total forage production area	70.8	-	-	-
Total crop nutrient demands	-	14,452	12,447	2,033
Nutrients supplied by manure from 476 beef cattle	-	6,475	2,127	3,828
Ratio to meet crop nutrients need by manure (%)	-	44.8	17.1	-
Nutrient supplied by fertilizer (kg)	-	15,593	4,515	1,288
Group III				
Wheat	21.1	1,688	1,688	0
Barley	36.3	2,541	2,541	0
Potatoes	13.0	1,820	1,300	1,170
Alfalfa	17.8	712	2,314	0
Maize	11.5	1,832	802	0
Rye	4.0	280	280	0
Cow vetches	18.2	728	1,274	0
Sugar beets	7.5	1,267	671	0
Fodder beet	5.6	448	392	0
Poppy	0.6	42	30	0
Other vegetables (bean fresh, okra, green pepper)	1.0	130	70	70
Group's total crop area	136.6	-	-	-
Group's total forage production area	93.4	-	-	-
Total crop nutrient demands	-	11,488	11,362	1,240
Nutrients supplied by manure from 846 beef cattle	-	11,747	3,858	6,944
Ratio to meet crop nutrients need by manure (%)	-	102.3	34.0	-
Nutrient supplied by fertilizer (kg)	-	12,991	4,593	150
Three group's total crop area	418.1	-	-	-
Three group's total forage production area	248.6	-	-	-
Three group's total nutrient demand (kg)	-	36,370	33,696	3,905
Three group's total nutrient supplied by manure (kg)	-	20,627	6,775	12,194
Ratio to meet total crop nutrients need by manure (%)	-	56.7	20.1	-
Three group's total nutrient supplied by fertilizer (kg)	-	38,066	12,429	1,550

manure increased. Ratio to meet total crop nutrient demand by manure for Group I, II and III were 22.0, 43.0 and 93.6%, respectively. The manure used on Group I farms is generally not adequate to meet total crop nutrient demands and the nutrients supplied by chemical fertilizers along with those by manure are within balance. Group II

Table 4: Economic loss and saving due to fertilizer and manure use by farm groups

Fertilizer and manure	Group I	Group II	Group III
Total crop nutrient demand (kg) (A)	20,949	28,932	24,090
Farm groups total crop area (ha) (B)	130.0	151.5	136.5
Crop nutrient demand (kg ha^{-1}) (C = A/B)	161.1	191.0	176.5
Total nutrient supplied by manure (kg) (D)	4617	12430	22549
Nutrient supplied by manure (kg ha^{-1}) (E = D/B)	35.5	82.0	165.2
Total nutrient supplied by fertilizer (kg) (F)	12,916	21,396	17,734
Nutrient supplied by fertilizer (kg ha^{-1}) (G = F/B)	99.4	141.2	129.9
Ratio of total crop nutrient demand met by manure (%) (H = D×100/A)	22.0	43.0	93.6
Saving due to manure use as fertilizer (YTL ha^{-1}) (I = E× Fertilizer price[1])	30.6	71.1	142.4
Total saving due to manure use as fertilizer (YTL) (J = B×I)	3,975	10,777	19,437
Total nutrient supplied by manure and fertilizer (kg ha^{-1}) (K = E+G)	134.9	223.3	295.1
Surplus as fertilizer (kg ha^{-1}) (L = K-C)	-	32.3	118.6
Total surplus as fertilizer (M = B×L)	-	4,894	16,192
Economic loss (YTL ha^{-1}) (N = L× fertilizer price[1])	-	28.0	102.3
Total economic loss (YTL) (O = N×B)	-	4,243	13,958

[1]1 kg Fertilizer price (NPK): Group I: 0.861 YTL, Group II: 0.867 YTL, Group III: 0.862 YTL, (1 USD = 1.34 YTL)

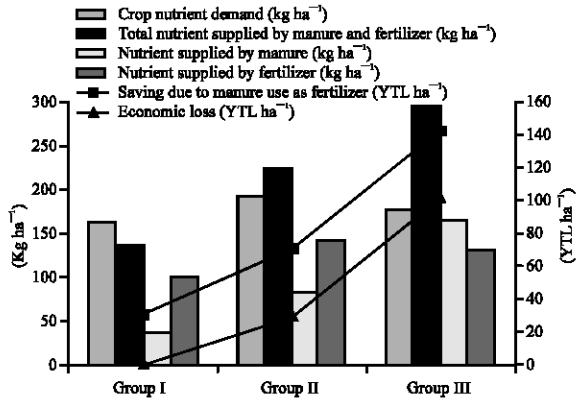

Fig. 1: Economic loss and saving due to fertilizer and manure use as NPK in the investigated farms

could meet a significant part, if not all, of the nutrient demands for crop production. Group III could meet almost all the nutrient demands for crop production (Fig. 1).

Fertilizer use in crop production in the investigated farms is important in sustainable use of soil and water and in terms of controlling pollution caused by agricultural practices. Nutrient needs of the crops for NPK and economic loss due to manure and over supplementation of chemical fertilizers are provided in Table 4. It was found that nutrient needs of crops as NPK for Group I, II and III was 161.1, 191.0 and 176.5 kg ha^{-1}, respectively. Nutrient needs depended on the type of crop produced in the farms. It was observed that in Group II crops needing more nutrients such as potatoes, sugar beets and fodder beets were grown. Manure supplied 35.5, 82.0 and 165.2 kg of nutrient need of crops in Group I, II and III, respectively. As farm size increased there was an increase in ratio of manure meeting crop nutrient need. Ratio of manure meeting crop nutrient need for Goup I, II and III were 22.0, 43.0 and 93.6%, respectively. Amount of chemical fertilizers used supplied 99.4, 141.2 and 129.9 kg of nutrient in Group I, II and III, respectively. An efficient manure management would possibly decrease dependency on chemical fertilizers and manure use would become profitable practice for farmers. In the study area, if extension services and encouragement is provided to the farmers on manure storage and use, nutrient supply cost and chemical fertilizer use would be decreased. When farmers used manure as fertilizer, amount of saving were 30.6, 71.1 and 142.4 YTL ha^{-1} for Group I, II and III, respectively (1 USD = 1.34 YTL). While, application of manure and chemical fertilizers in Group I did not meet all crop nutrient demands there was surplus nutrient supplementation in Group II and III due to chemical fertilizer use causing economic loss. Amount of surplus NPK nutrient supplementation in Group II and III was 32.3 and 118.6 kg ha^{-1}, respectively. Economic loss due to surplus supplementation of NPK nutrient in Group II and III was 4 243 and 13 958 YTL, respectively (1 SD = 1.34 YTL).

In different studies conducted in Turkey Esengun *et al.* (1994), Yilmaz (1996) and Demircan and Yilmaz (2005) found that there were economic loss due to surplus chemical fertilizer use. While, proper use of manure and chemical fertilizers improve crop production and soil productivity, mismanagement of fertilizers and manure results in inefficiencies of plant nutrient use, leading to a loss in farmer profits, potential damage to the environment and inefficient use of energy (Guzel *et al.*, 2002). Thus, in order not to cause a loss in soil fertility, reduced crop yields and environmental degradation by a sustained imbalance in the application of nutrients, proper fertilizer use should be practiced. The implementation of proper soil management practices, such as timely site-specific and crop-specific nutrient placements are highly effective in optimizing the efficiency of nutrient use. Innovative application techniques, such as precision farming and fertigation, enhance fertilization efficiency (IFA, 2000; Morvaridi, 1998; Onar *et al.*, 1996). Fertilizer use provides clear productivity benefits and in Turkey, often causes only relatively low levels of environmental

Table 5: Fertilizer and manure use, price relation of manure and fertilizer, average total forage production area, percent of feed source supplied from on-farm

Assessment criterion	Group I	Group II	Group III
Animal density (Number of cattle/area manured) (head ha^{-1})	1.500	3.100	6.200
Total manure use (tons)	205.600	553.400	1004.000
Manure use intensity (ttons ha^{-1})	1.600	3.700	7.400
Manure price (bulk) (YTL tons^{-1}) (A)	4.700	4.600	4.300
Manure NPK equivalent price*, YTL kg^{-1} (B = A/22.5)	0.210	0.203	0.190
Total fertilizer use (tons)	33.900	57.600	48.500
Fertilizer use intensity (kg ha^{-1})	261.100	380.300	355.100
Fertilizer price (NPK) (YTL kg^{-1}) (C)	0.861	0.867	0.862
Price ratio (D = C/B)	4.100	4.300	4.500
Average forage production area (ha)	3.100	2.400	4.000
Feed source supplied from on-farm (%)	24.700	18.800	37.000

*Price ratio is based on manure conversion: 1 tons bulk equivalent. 22.5 kg nutrients (NPK)

damage. In addition, concern had arisen over environmental pollution resulting from fertilizer use, including the possible contamination of surface and drainage water and lake eutrophication (SPO, 1996b; Uslu and Turkmen, 1987; Kaplan *et al*., 2000). Depending on the point of view or necessity, manure either can be considered as livestock production waste by-product or a valuable source of plant nutrients. If a producer perceives manure as a waste by-product, then research and analysis should focus on evaluating manure management techniques that reduce the nutrient content of applied manure, or reduce the adverse environmental impact of manure at least cost to the producer and society (Unterschultz and Jeffrey, 2001). On the other hand, if manure is a valuable resource, Fleming *et al*. (1998) suggested that policy-makers should encourage farmers adopt nutrient management techniques that increase the value of the manure.

Interaction of the price and use of manure and fertilizer: Price relation of manure and chemical fertilizer, average total forage production area, percent of feed source supplied from on-farm and fertilizer and manure use are provided in Table 5. As animal density increased manure use intensity increased (Table 5). Average manure use intensity was 1.6, 3.7 and 7.4 tons ha^{-1} for Group I, II and III, respectively. Fertilizer use intensity was higher in Group II.

A total of 140.2 tons of chemical fertilizers were used. Of these fertilizers 38.8, 22.9, 18.3, 8.8, 5.7, 5.4 and 0.1% were di-ammonium phosphate-DAP (18-46-0), Urea (46% N), ammonium nitrate (33%), composed NPK (15-15-15), ammonium sulphate (21% N), composed NPK (20-20-0) and triple superphosphate-TSP, respectively. The price of commonly used fertilizers was approximately 0.861, 0.867 and 0.862 YTL kg^{-1} of NPK for Group I, II and III, respectively. Fertilizer price expressed in terms of the nutrients (NPK) is four times more expensive than that of manure (Table 5). Even though fertilizer price was higher than other groups, Group II had higher fertilizer use intensity.

Table 6: Evaluation of economy and nutrient balance as the performance criterion

	Farm category		
Management consideration	Group I	Group II	Group III
Manure nutrient balance	Deficit	Deficit	Deficit
Total nutrient balance	Deficit	Surplus	Surplus
Economics of manure management	Positive	Positive	Positive
Economics of nutrients management	Positive	Negative	Negative

Average forage production area was 3.1, 2.4 and 4.0 ha for Group I, II and III, respectively. There were differences among farms in terms of feed source supplied from on-farm and this was related to forage and grain production area and was 24.7, 18.8 and 37.0% for Group I, II and III, respectively.

Manure management and nutrients balance: Since, nutrient management is a continuous process that is part of many farm operations, the decisions in the process and the level of nutrient management assistance that will be required will depend on the farmer and the organization of the farm (PDEP, 1999). In general, nutrient management engaged in optimizing the economic return from nutrients is used for crop production. Today, the agronomic and economic demands of nutrient management remain central, but the process is being expanded to include the potential environmental impacts of nutrients on the entire farm operation (Risse *et al*., 2001). Evaluation of economy and nutrient balance as performance criterion of farms in each farm groups are summarized in Table 6. In terms of manure management all the farms applied the manure produced in their farms to the field. Neither of the farm groups met crop nutrient needs by manure application. Thus, farmers attempted to meet crop nutrient needs by fertilizer use. As a result of chemical fertilizer use, Group II and III had nutrient surplus, whereas Group I had deficit. In terms of economics, Group I had no loss whereas, Group II and III had loss due to surplus chemical fertilizer use.

CONCLUSION

Results showed that manure itself does not meet crop nutrient need for neither farms. Thus, chemical fertilizer use is necessary to meet this deficit. However, as a result of chemical fertilizer use Group II and III had nutrient surplus resulting in economic losses. When, farmers used manure as fertilizer, expenditure on chemical fertilizer decreased and savings increased. This saving increased as farm size increased. This shows that farmers are not aware of crop nutrient needs and do not know how much nutrient is supplied by manure and chemical fertilizer

application. Thus, extension programs and policies to inform and to encourage adoption of manure management practices by farmers are necessity. Educational programs informing farmers the economic value of manure as a fertilizer would help farmers economically as manure is a substitute for chemical fertilizer. Chemical fertilizer prices are increasing parallel to energy prices and increased fertilizer prices have increased the value of manure. Thus, in addition to manure application optimum fertilizer application rates producing maximum yield should be developed.

Since, fertilizer production requires non-renewable energy sources, sustainability of fertilizer production might be at risk in the future. Conscious use of chemical fertilizers would become more important for underdeveloped countries having limited resources. Turkey produces substantial amount of manure but produced manure is not being used properly. For this reason, policy and research encouraging manure use should be developed for Turkey and results of this research would be useful for policy developing and would shed some light on future research on this subject in Turkey.

Literature show that application of manure improves soil properties, increases yield, reduces erosion and reduces nutrient leaches. On the other hand, overuse of chemical fertilizers rise concern over environmental pollution due to possible contamination of surface and drainage water and lake eutrophication. Considering all these points mentioned above it could be suggested that addition to manure application, research effort on determining optimum chemical fertilizer amount improving crop yield and meeting future environmental goals is important.

REFERENCES

Adhikari, M., K.P. Paudel, R.N. Martin and M.V. Gauthier, 2005. Economics of dairy waste use as fertilizer in central Texas. Waste Manage., 25: 1067-1074. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6VFR-4H0S1BG-1&_user=746176&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000041639&_version=1&_urlVersion=0&_userid=746176&md5=fe7592d8ce301f7edf47888cc2a8c79f.

Anonymous, 2004. Afyon ili tarim master plani. Afyon Tarim Il Mudurlugu. (Reports of Afyon Province (Unpublished). Office of the Ministry of Agriculture and Rural Affaires).

Araji, A.A., Z.O. Abdo and P. Joyse, 2001. Efficient use of animal manure on cropland-economic analysis. Bioresour. Technol., 79: 179-191. http://www.ingentaconnect.com/content/els/09608524/2001/00000079/00000002/art00042.

Demircan, V. and H. Yilmaz, 2005. Isparta ili elma uretiminde gubre kullanim duzeyi ve masrafinin belirlenmesi (Determination of cost and level of fertilizer use in apple production in Isparta province) Cukurova Univ. J. Fac. Agric., 20 (3): 109-116. ISBN: 1300-4700. Adana.

Esengun, K., O. Karkacier ve and Y. Akcay, 1994. Secilmis bir bolgede tarimsal arastirma kuruluslarinca onerilen gubre kullanimi ile uretici uygulamalarinin karsilastirilmasi ve optimal gubre kullanim duzeyinin belirlenmesi (Tokat Ili Ornegi). (Comparison of fertilizer amount recommended by agricultural research institute with farmer's application and determination of optimal fertilization amount in a chosen region, case study in Tokat). First Agricultural Economics Congress of Turkey, Izmir, pp: 141-149.

Eyupoglu, F., 2002. Turkiye gubre gereksinimi, tuketimi ve gelecegi, (Fertilizer need of Turkey, consumption and future). Republic of Turkey General Directorate of Rural Services (GDRS) Soil and Fertilizer Research Institute Directorate. General publication no 2, technical report no T-2, ISBN: 9751932904. Ankara.

FAO, 2004. FAOSTAT Citation database results. FAO. http://faostat.fao.org/faostat.

Fleming, R.A., B.A. Bobcock and E. Wang, 1998. Resource or Waste? The economics of swine manure storage and management. Rev. Agr. Econ., 20 (1): 96-113. http://ideas.repec.org/p/isu/genres/1087.html.

Freeze, B.S., C. Webber, C.W. Lindwall and J.F. Dormaar, 1993. Risk simulation of the economics of manure application to restore eroded wheat cropland. Can J. Soil Sci., 73: 267-274. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V24-438BNFD-B&_user=746176&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000041639&_version=1&_urlVersion=0&_userid=746176&md5=d2d8b42f50197d187bdeb2f1fe3c8f4d.

GDRS, 1995. Turkiye gubre ve gubreleme rehberi. (Fertilizers and fertilization guide of Turkey, Republic of Turkey General Directorate of Rural Services. Soil and Fertilizer Research Institute Directorate. General publication no 209, technical report no T-66, Ankara, pp: 205-213.

Guzel, N., K.Y. Gulut and G. Buyuk, 2002. Toprak verimliligi ve gubreler: bitki besin elementlerinin yonetimine giris. (Soil fertility and fertilizers: Introduction to plant nutrient management), Cukurova University, Faculty of Agricultural, General publication no: 246, textbook publication no: A-80. pp: 1-654. ISBN: 975-487-009-3. Adana.

IFA, 2000. Mineral fertilizer distribution and the environment. International fertilizer industry association, United Nations Environment Programme, March 2000, Paris. ISBN: 2-9506299-4-6. http://www.fertilizer.org/Home-Page/LIBRARY/Books-selection/Fertilizer-production-technology-and-distribution.html2/Mineral-Fertilizer-Distribution-and-the-Environment.html.

Jokela, W.E., 1992. Nitrogen fertilizer and dairy manure effects of corn yield and soil nitrate. Soil Sci. Soc. Am. J., 56 (1): 148-154. http://soil.scijournals.org/cgi/content/abstract/56/1/148.

Kacar, B., 1997. Gubre Bilgisi (Fertilizers information). Ankara University Faculty of Agriculture Publication no: 1490, Textbook no: 449, pp: 1-441. ISBN: 975-482-22-0. Ankara.

Kaplan, M., M. Aktas, A. Gurses, M. Alpaslan and S. Sonmez, 2000. Turkiye gubre uretim ve tuketiminin degerlendirilmesi. (Evaluation of Turkey's fertilizer production and consumption). Technical Congress of Turk. Agric. Eng. Ankara, pp: 2.

LIFE, 2005. Exploitation of agricultural residues in Turkey. Funded by the European Commission under the LIFE Programme EC Contract Number LIFE03 TCY/TR/000061. Training Course. Adana/Turkey, pp: 1-185. http://www.mam.gov.tr/enstituler/kce/projeler/life.htm.

MARA, 2006. Turkiye gubre ve gubreleme rehberi. (Fertilizers and fertilization guide of Turkey), Republic of Turkey Ministry of Agriculture and Rural Affaires. General Directorate of Agricultural Research. Soil and Fertilizer Research Institute Directorate. General publication no: 231, Technical report no T-69, Ankara. ISBN: 975-407-208-6.

Morvaridi, B., 1998. Environmental degradation in Eastern Turkey: The case of contract farming. Transformations of Middle Eastern Natural Environments: Legacies And Lessons. Yale School of Forestry And Environmental Studies, Bulletin Series, pp: 108-123. http://environment.yale.edu/documents/downloads/0-9/103morvaridi.pdf.

Olson, M.B. and A.B. Paterson, 2005. Implications of Moving to a Phosphorus Based System for Manure Application. http://www1.agric.gov.ab.ca/$ department/deptdocs.nsf/all/epw9889/$file/Brent_Paterson.pdf?OpenElement.

Onar, A.N., H. Buyukgungor, N. Balkaya and N. Genc, 1996. Yapay gubre kullaniminin neden oldugu yeraltisuyu kirliliginin arastirilmasi. A research on groundwater pollution caused by chemical fertilizer use. Symposia on Agriculture-Environment relationship, Sustainable use of natural resources, Mersin University Faculty of Engineering. Mersin, pp: 93-102.

PDEP, 1999. Field application of manure a supplement to manure management for environmental protection. Pennsylvania Department Of Environmental Protection. Commonwealth Of Pennsylvania, Harrisburg. Document Number: 361-0300-002. http://panutrientmgmt.cas.psu.edu/pdf/rp_field_app_manure.pdf.

Peterson, T.A. and M.P. Russelle, 1991. Alfalfa and the nitrogen cycle in the corn-belt. J Soil Water Conserv 46: 229-235. http://www.jswconline.org/content/46/3/229.full.pdf+html?cited-by=yes&legid=jswc;46/3/229.

Risse, L.M., M.L. Cabrera, A.J. Franzluebbers, J.W. Gaskin, J.E. Gilley, R. Killorn, D.E. Radcliffe, W.E. Tollner and H. Zhang, 2001. Land application of manure for beneficial reuse. The National Center for Manure and Animal Waste Management. USDA Fund for Rural America. http://www.ars.usda.gov/SP2UserFiles/Place/66120900/SoilManagementAndCarbon Sequestration/2001ajfB02.pdf.

Sayin, C., N.M. Mencet and B. Ozkan, 2005. Assessing of energy policies based on Turkish agriculture: Current status and some implications. Energy Policy, 33: 2361-2373. http://www.sciencedirect.com/science?_ob=ArticleURL&_udi=B6V2W-4CVX0FB-2&_user=746176&_rdoc=1&_fmt=&_orig=search&_sort=d&view=c&_acct=C000041639&_version=1&_urlVersion=0&_userid=746176&md5=13584856fbde8e453921c891f4535bfb.

SIS, 2005. Agricultural production value and prices, State Institution of Statistics, Prime Ministry Republic of Turkey.

SIS, 2003. Turkiye istatistik yilligi (Statistical yearbook of Turkey). State Institute of Statistics, Prime Ministry Republic of Turkey.

SIS, 2004. Genel tarim sayimi 2001 (General Agricultural Census 2001). Result of the agricultural holdings (households) survey. State Institute of Statistics, Prime Ministry Republic of Turkey No.2924, Ankara.

SPO, 1993. Turkiye aile yapisi arastirmasi (A research on Turkish family structure). State Planning Organization, Publications no. 2312, Ankara.

SPO, 1996a. Afyon Ili Raporu. (Reports of Afyon Province), State Planning Organization, Publications no: 2463, Ankara, Turkey.

SPO, 1996b. Gubre ozel ihtisas komisyonu raporu, (Fertilizer sector special commission report), Seventh Development Plan, State Planning Organization, Publications no: 2445-SCR:502, Ankara, Turkey.

Thompson, R.B., D. Morse, K.A. Kelling and L.E. Lanyon, 1997. Computer programs that calculate manure application rates. J. Prod. Agric., 10 (1): 58-69. http://cat.inist.fr/?aModele=afficheN&cpsidt=2662124.

Tanksley, A.K. and E.C. Martin, 2003. Application of animal manure/compost in an irrigated alfalfa production system. ASAE Annual International Meeting. Sponsored by American Society of Agricultural Engineers (ASAE) Riviera Hotel and Convention Center. Las Vegas, Nevada, USA. An ASAE Meeting Presentation, Paper 32370, pp: 1-37. http://www.mans.edu.eg/projects/heepf/ilppp/cources/12/pdf%20course/45/tsmed%2035wy/martintanksley073003.pdf.

Unterschultz, R.J. and R.S. Jeffrey, 2001. Economic evaluation of manure management and farm gate applications. A literature review of environmental and economic aspects of manure management in Alberta's livestock sectors. Project report no: 01-03. pp: 1-64. Edmonton, Canada. http://econpapers.repec.org/paper/agsualbpr/24057.htm.

Uslu, O. and A. Turkmen, 1987. Su kirliligi ve kontrolu (Water pollution and control). Publication series of Environment General Directorate of Prime Ministry of Turkish Republic. Ankara, 1: 251-265.

WB, 2004. A review of the impact of the reform of agricultural sector subsidization, Turkey. Environmentally and Socially Sustainable Development Unit Europe and Central Asia Region. The World Bank Report, pp: 1-69. http:// site resources.worldbank.org/.INTTURKEY/Resources/361616-1121189080247/turkey-ag-complete.pdf.

Yamane, T., 2001. Basic Sampling Methods. Translators: Esin, A., M.A. Bakir, C. Aydin, E. Gurbuzsel (Eds.). Literatur Publishing (in Turkish). ISBN: 975-8431X. Istanbul.

Yilmaz, H., 2003. Fertilizer in Turkish agriculture: Policies and economic analysis of fertilizer subsidy. Department of agricultural economics institute of natural and applied sciences University of Cukurova, Ph.D Thesis, Project no: FBE- 2002.D.101. Adana, Turkey.

Yilmaz, H., 1996. Kimyasal gubrede yeni subvansiyon uygulamasinin Yuregir ilcesi koylerinde degerlendirilmesi (Evaluation of new fertilizer subsidy application in villages of Yuregir district). Department of Agricultural Economics Institute of Natural And Applied Sciences University of Cukurova (Masters Thesis). Adana, Turkey.