TARIM BİLİMLERİ DERGİSİ 2008, 14 (3) 284-287
ANKARA ÜNİVERSİTESİ ZİRAAT FAKÜLTESİ
DOI: 10.1501/Tarimbil_0000001042

# The Cost of Soil Lost Caused by Sugar Beet Harvest: A case study for Turkey

Mehmet PARLAK[1] Siyami KARACA[2] Nilüfer TÜRKMEN[2]

Geliş Tarihi: 22.04.2008 Kabul Tarihi: 15.07.2008

**Abstract:** Studies related with soil loss due to crop harvesting have been recently included in soil erosion investigations. Harvest of root crops like sugar beet causes significant soil loss. This study was conducted to determine soil loss and to estimate the economic value of related losses of plant nutrients during 2005**.** Soil losses were compiled from the reports of the General Directorate of the Turkish Sugar Industry. According to these reports, 47 866 t soil per year was transported from sugar beet fields in Ankara province, for which economic value of plant nutrients was estimated to be US$ 204 158. The estimated values for Turkey are approximately 951 000 t and 4 056 203 US$ for soil loss and the economic value of lost N, P, and K.

**Key Words:** Soil loss, soil erosion, sugar beet, soil tare, Turkey

## Şeker Pancarı Hasadının Neden Olduğu Toprak Kaybının Maliyeti: Türkiye İçin Bir Durum Çalışması

**Öz:** Bitki hasadı nedeniyle toprak kaybına ilişkin çalışmalar son dönemde toprak erozyonu araştırmalarına dahil edilmiştir. Şeker pancarı gibi yumrulu bitkiler hasat edildiğinde önemli toprak kayıplarına yol açmaktadır. Bu araştırma 2005 yılında şeker pancarı hasadıyla kaybolan toprak kayıplarını ve bitki besin maddesi maliyetlerini tahmin etmek için yapılmıştır. Toprak kayıpları Türkiye Şeker Fabrikaları Genel Müdürlüğü' nün raporlarından sağlanmıştır. Bu raporlara göre Ankara' da şeker pancarı tarlalarından yılda 47 866 t toprak taşınmıştır. Bu toprakla taşınan bitki besin maddelerinin ekonomik değerinin 204 158 dolar olduğu tahmin edilmiştir. Türkiye' de toprak kaybının yaklaşık 951 000 t ve N,P, K kaybı ekonomik değerinin ise 4 056 203 dolar olduğu tahmin edilmektedir.

**Anahtar Kelimeler:** Toprak kaybı, toprak erozyonu, şeker pancarı, toprak firesi, Türkiye

### Introduction

The impacts of agricultural activities on soil degradation processes have received considerable attention. Significant soil losses occur also during the harvest of crops such as sugar beet (*Beta vulgaris* L.), potato (*Solanum tuberosum* L.), carrot (*Daucus carota* L.), onion (*Allium cepa* L.), radish (*Raphanus sativus* L.), and leek (*Allium porrum* L.). Fine earth adhering to the crop and loose soil and rock fragments are harvested and removed from the field together with the crop (Auerswald et al. 2006, Li et al. 2006, Poesen et al. 2001, Ruysschaert et al. 2004, 2005, 2006).

Although soil loss due to crop harvesting (SLCH) may be the same order of magnitude as water and tillage erosion values, few studies have incorporated SLCH as a soil erosion process. Mean SLCH values for sugar beet calculated from soil tare data measured in sugar factories were 6 t $ha^{-1}$ harvest for the Netherlands, 14 t $ha^{-1}$ harvest for France, 9 t $ha^{-1}$ harvest for Belgium and 5 t $ha^{-1}$ harvest for Germany for the period 1978-2000 (Ruysschaert et al. 2005), and 3.8 t $ha^{-1}$ harvest for Turkey (Oruç and Güngör 2000, Öztaş et al. 2002).

Sugar beet harvest is done mechanically in European countries. Harvest is also being mechanized in Turkey, but small produces are still harvesting by hand.

The on- and off-site environment and economic consequences of SLCH are considerable. On-site, valuable top soil is lost from the field. Added to soil loss caused by other soil erosion processes, the critical soil loss tolerance level may be exceeded, resulting in

[1]Çanakkale Onsekiz Mart University, Lapseki Vocational School-Çanakkale
[2]Ankara University Faculty of Agriculture Department of Soil Science-Ankara

a lowering of the soil profile and related consequences, such as decline of crop productivity. Moreover, plant nutrients and soil organic matter are removed together with the exported soil, which ultimately will have to be replenished by the farmer, resulting in an additional cost (Oruç and Güngör 2000, Öztaş et al. 2002). SLCH also has negative off-site consequences for the environment. Ruysschaert et al. (2004) attributed these consequences to 1) transport of soil, causing energy loss and air pollution, 2) cleaning of the soil from the beet, resulting in energy and water loss, 3) storage of soil in sediment ponds, which causes loss of space and odor nuisance and finally 4) disposal of the soil, which may spread diseases and pollution.

Five hundred million tons of soil rich in plant nutrients are carried away by water erosion every year in Turkey (Cangir et al. 2000). Sugar beet production in Turkey is 9 331 850 t in 2005 (Anonymous 2006). An average soil tare for sugar beet in Turkey was 10.19 % of the gross weight of the sugar beet harvested in 2005 (Anonymous 2006). This indicates that about 951 000 t of soil rich in organic matter and plant nutrients are lost annually in Turkey (Anonymous 2006). This represents 0.19 % of the soil lost by water erosion in Turkey.

The objectives of our study were to estimate the cost of soil and plant nutrients lost due to sugar beet harvesting in Ankara province and in Turkey.

## Materials and Methods

Ankara province is located at 39° 57' N latitudes and 32° 53' E longitudes in Central Turkey. There is about 9170 ha of sugar beet growing area in Ankara and the total production is approximately 455 000 t in 2005 (Anonymous 2006). Sugar beet production of Turkey in 2005 was 9 331 850 t and planting area was 221 950 ha (Anonymous 2006). Long term means of monthly precipitation and temperature of the research area are 399.2 mm and 11.8 °C**,** respectively (Anonymous 2005). Sugar beet is harvested within October and November in Ankara. The amount of rainfall during the harvesting period of 2005 was 28 and and 48.1 mm, respectively.

The amounts of soil tare for 2005 were calculated from the data of the General Directorate of Turkish Sugar Industry (Anonymous 2006). Soil tare was calculated as;

Soil tare = total mass delivered by the growers – 5% top tare (percentage of the gross delivery) – mass of beet processed by the sugar factories (Oruç and Güngör 2000).

The amounts of plant nutrients in soil lost by harvest were estimated by analyzing soil samples taken from the delivery sites. Twenty one adhering soil samples were collected from seven different sugar beet delivery sites in Ankara province in November 2005.

The soil samples were air-dried, sieved to remove soil particles > 2mm, and stored in air-tight plastic boxes until analysis. Organic matter was determined by oxidation with potassium dichromate (Nelson and Sommers 1982). Total nitrogen was determined by Kjeldahl automatic analyzer using the Bremner method (Bremner 1982). Total phosphorus was determined calorimetrically according to the method of Olsen and Sommers (Olsen and Sommers 1982). Exchangeable potassium was carried out following the procedures described by Thomas (1982).

Plant nutrient losses fertility equivalents was calculated as;

Losses of N = 1719 mg $kg^{-1}$ (Table 1) x 47 866 t = 82 281 kg

Losses of total $P_2O_5$ = 1469,2 mg $kg^{-1}$ (Table 1) x 47 866 t = 70 324 kg

Losses of exchangeable $K_2O$ = 1707 mg $kg^{-1}$ (Table 1) x 47 866 t = 81 707 kg

Amount of urea = 100 x 82 281 kg (Table 2) / 46 = 178 871 kg = 178,87 t

Amount of triple superphosphate= 100 x 70 324 kg (Table 2) / 43 = 163 544 kg = 163,54 t

Amount of $K_2SO_4$ = 100x 81 707 kg (Table 2) / 50 = 163 414 kg = 163, 41 t

## Results and Discussion

Sugar beet production in Ankara province, Turkey was 455 000 tons from 9170 ha land, in 2005 (Anonymous 2006). Soil tare was estimated 10.52%, which equals to 47 866 t (5.22 t $ha^{-1}$) soil that has been lost in a year. Using the same method the soil tare for the whole of Turkey was estimated as 10.19%. The annual sugar beet production of Turkey is 9 331 850 t which translates to about 951 000 t (4.28 t $ha^{-1}$) of soil removed annually (Anonymous 2006).

Organic matter, total nitrogen, total phosphorus and exchangeable potassium results of the soil samples are given in Table 1.

Table 1. Some chemical properties of soil samples collected in Ankara (n=21).

| Soil chemical property | Mean | Standart deviation | Coefficient of variation (%) | Minimum | Maximum |
|---|---|---|---|---|---|
| Organic matter (%) | 3,44 | 1,95 | 56,68 | 1,38 | 7,87 |
| Total N (mg $kg^{-1}$) | 1719 | 975 | 56,72 | 690 | 3940 |
| Total P (mg $P_2O_5$ $kg^{-1}$) | 1469,2 | 349 | 23,75 | 870 | 2322 |
| Exchangeable K (mg $K_2O$ $kg^{-1}$) | 1707 | 717 | 42 | 542 | 3157 |

Table 2. The cost of N, P, and K losses associated with soil loss due to sugar beet harvesting for Ankara province

| Nutrient | Losses (kg) | Fertility equivalents | Unit price* (US$ $t^{-1}$) | Total cost (US$ ) |
|---|---|---|---|---|
| Total Nitrogen | 82 281 | 178,87 t urea (46 %) | 413 | 73 873 |
| Total $P_2O_5$ | 70 324 | 163,54 t triple superphosphate (43 %) | 370 | 60 509 |
| Exchangeable $K_2O$ | 81 707 | 163,41 t $K_2SO_4$ (50%) | 427 | 69 776 |
| | | | Total | 204 158 |

* Unit price of fertilizer was calculated according to commercial sale value.

Texture of sugar beet cultivated area soils of Ankara Sugar Factory are generally clay, clay loam, and silty clay loam (Munsuz et al. 1996).

Table 2 shows annual soil and plant nutrient losses by sugar beet harvest in Ankara. Estimated annual costs of these losses are US$ 204 158 in terms of fertilizer. 951 000 t of soil has been removed in Turkey due to the sugar beet production and it is estimated that it resulted in US$ 4 056 203 loss [951 000 t (Annual soil loss in sugar beet production in Turkey) x US$ 204 158 ( The cost of annual soil loss in sugar beet production in Ankara province) / 47 866 t (Annual soil loss in sugar beet production in Ankara province)] in terms of N, P and K nutrients.

Öztaş et al. (2002) calculated the annual fertilizer cost in Erzurum due to the plant nutrient loss as US$ 7500. Because of both increasing fertilizer costs in Turkey and controlling factors of SLCH (soil, plant, agronomic practices and harvest technique), cost figures are different from ones of Öztaş et al. (2002). Commercial fertilizer-produce cost relation has to be considered in fertilizer use. Cost of commercial fertilizer was 6.6 times more in 2003 than in 1999, but cost of 6 different produce was only 3.8 times expensive (Kacar 2004). As long as agricultural produces do not have their real value, it is unreasonable to expect growers to allocate more money to fertilizers and increase their use.

## Conclusion

The farmers should be informed about the significance of minimizing soil tare on sugar beet fields by training them on improved sugar beet growing methods and mechanization.

Sugar beet has been produced for over 80 years in Turkey. Undoubted SLCH has reduced the thickness of soil profile. This fact has to be taken into account in soil loss estimates.

## References

Anonymous 2005. Ankara Province Meteorological Survey Station Records (unpublished), Ankara. (in Turkish)

Anonymous 2006. Agricultural Report. The General Directorate of Turkish Sugar Industry. Ankara. 68 p. (in Turkish)

Auerswald, K., G. Gerl and M. Kainz. 2006. Influence of cropping system on harvest erosion under potato. Soil and Tillage Research 89: 22-34.

Bremner, S.M. 1982. Total Nitrogen. Pp.595-624. In: Page, L. A., R. H. Miller, D.R. Keeney, ed. Methods of Soil Analysis, Part 2. Chemical and Microbiological Properties, Madison, Wisconsin, American Society of Agronomy.

Cangir, C., S.Kapur, D. Boyraz. E. Akça and H. Eswaran. 2000. An assessment of land resource consumption in relation to land degradation in Turkey. Journal of Soil and Water Conservation 55(3): 253-259.

Kacar, B. 2004. How can evaluated and what can be done for chemical fertilizer consumption? In: The Turkey Third National Fertilizer Congress, Agriculture- Industry-Environment Proceedings: 103-110. October 11-13, 2004,Tokat. (in Turkish).

Li, Y., G. Ruysschaert, J. Poesen, Q.W. Zhang, L.Y. Bai, L. Li and L.F. Sun. 2006. Soil losses due to potato and sugar beet harvesting in NE China. Earth Surface Processes and Landforms 31: 1003-1016.

Munsuz, N., G. Çaycı, A. Sueri, M. Turhan, M. Kibar, N. Akıncı, T. Mühürdaroğlu and K. Erel. 1996. Relationships between clay minerals and potassium release capacities of sugar beet cultivated area soils of Central Anatolia Sugar Factories. Pp.59-60. The General Directorate of Turkish Sugar Industry. Ankara. (in Turkish with English abstract)

Nelson, D.W. and L.E. Sommers. 1982. Total Carbon, Organic Carbon and Organic Matter. Pp.539-579. In: Page, L. A., R.H. Miller and D.R. Keeney, ed. Methods of Soil Analysis, Part 2. Chemical and Microbiological Properties, Madison, Wisconsin, American Society of Agronomy.

Olsen, S.R. and L.E. Sommers. 1982. Phosphorus. Pp.403-427. In: Page, L. A., R.H. Miller and D.R. Keeney, ed. Methods of Soil Analysis, Part 2. Chemical and Microbiological Properties, Madison, Wisconsin, American Society of Agronomy.

Oruç, N. and H. Güngör. 2000. A study on the soil tare of sugar beet in Eskişehir- Turkey. Pp. 258-261. In: Proceedings of the International Symposium on Desertification. Konya, Turkey. Soil Science Society of Turkey.

Öztaş, T., A.K. Özbek and M. Turan. 2002. The cost of soil lost from fields due to removal on harvested sugarbeet: a case study in Turkey. Soil Use and Management 18: 236-237.

Poesen, J., G. Verstraeten, R. Soenens and L. Seynaeve. 2001. Soil losses due to harvesting of chicory roots and sugar beet: an underrated geomorphic process? Catena 43: 35-47.

Ruysschaert, G., J. Poesen, G. Verstraeten and G. Govers. 2004. Soil loss due to crop harvesting: Significance and determining factors. Progress in Physical Geography 28: 467-501.

Ruysschaert, G., J. Poesen, G. Verstraeten and G. Govers. 2005. Interannual variation of soil losses due to sugar beet harvesting in West Europea. Agriculture, Ecosystems and Environment 107: 317-329.

Ruysschaert, G., J. Poesen, G. Verstraeten and G. Govers. 2006. Soil losses due to mechanized potato harvesting. Soil and Tillage Research 86: 52-72.

Thomas, G. W. 1982. Exchangeable cations. Pp.159-165. In: Page, L. A., R. H. Miller, D.R. Keeney, ed. Methods of Soil Analysis, Part 2. Chemical and Microbiological Properties, Madison, Wisconsin, American Society of Agronomy.

**Communication Address:**
Mehmet PARLAK
Çanakkale Onsekiz Mart University, Lapseki Vocational School, 17800 Çanakkale
Tel: 0 286 512 51 66 / 121
E-mail: mehmetparlak06@hotmail.com