

CARBON DIOXIDE EMISSIONS RELATED TO FUEL CONSUMPTION FOR GROUNDNUT PRODUCTION IN TURKEY

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Abstract

The main objective of this study is to quantify and evaluate CO₂ emissions related to fuel consumption for groundnut cultivation in Turkey between 2011 and 2016. The methods were used for calculating CO₂ emissions are recommended by the Intergovernmental Panel on Climate Change (IPCC). Between 2011 and 2016, in Turkey, peanut was produced on an area of 35325.45 ha. The average groundnut production and the average yield were 129464 ton and 3655 kg per hectare (ha) over the last five-year period. It was found that the average fuel (diesel) consumption for groundnut cultivation were 13.06 g per kg of seed yield. The total CO₂ emissions based on lower heating value of diesel fuel and lubricant oil were 5551.3 t CO₂ per year. It was calculated that the average CO₂ emission was 43.16 g per kg of groundnut seed.

Key words: CO₂ emissions, groundnut production, fuel consumption, Turkey.

INTRODUCTION

It is predicted that global CO₂ emissions, which remained almost constant in the last three years, may rise again in 2017. According to a statement made by the Global Carbon Project (GCP, 2017) based on data not yet finalized, CO₂ emissions from human activities will increase by 2% in 2017. The main factor in this increase is that consumption of coal in China has started to increase again. China will be responsible for 30% of global emissions alone, with CO₂ emissions rising by 3.5% in 2017. It is reported that the slowing of the US and European economies in decarbonization will be another important factor in the increase of emissions. In December 2017, the Council of Europe recommended that member states of the European Union determine binding emission reduction targets in the transport and industrial sectors, excluding buildings, agricultural sector non-CO₂ greenhouse gas emissions, waste management, aviation and navigation. According to the proposal, EU member states will have to set binding emission reduction targets in these areas between 2021-2030. These targets will be between 0% and 40% of 2005 levels and will be in line with the main

target of 30%, based on countries' per capita gross domestic product (GDP). The European Union has pledged to reduce greenhouse gas emissions by 2030 to at least 40% below 1990 levels through the declaration of intent under the Paris Climate Agreement.

The sustainable production of agricultural products by reducing the use of fossil energy is very important. The effective energy use in agriculture is one of the conditions for sustainable agricultural production, since it provides financial savings, fossil fuels preservation and air pollution reduction (Pervanchon et al., 2002). To develop production systems that require less fossil energy and at the same time maintain satisfactory performance and reduce greenhouse gas emissions, requires efficient use of fossil energy in agricultural systems.

The main objective of this study is to quantify and evaluate CO₂ emissions related to fuel consumption for the groundnut cultivation in agricultural regions of Turkey. The CO₂ emissions associated with direct fuel and lubricant oil consumptions are estimated according to the Intergovernmental Panel on Climate Change (IPCC) approach. The specific values for fuel consumption, seed production,

energy consumption and CO₂ emission were defined to analyze the relationship between fuel consumption and CO₂ emission for groundnut production.

MATERIALS AND METHODS

The CO₂ default emission factors depending on fuel type based on lower heating values are from IPCC, 1996, Volume 2, Section 1 (Table 1).

Table 1. Emission Factors and Heating Values for Diesel Fuel and Lubricant (IPCC, 1996)

Fuel type	Lower heating value (GJ/L)	Emission factors (kg CO ₂ /GJ)
Diesel	0.0371	74.01
Lubricants	0.0382	73.28

The methods for calculating CO₂ emissions recommended by the *GHG Protocol - Mobile Guide (03/21/05) v1.3 (Calculating CO₂ Emissions from Mobile Sources Guidance to calculation worksheets)* were used in this study. The following equation outlines the recommended approach to calculating CO₂ emissions based on fuel use (assuming data is first obtained in terms of mass or volume).

CO₂ emissions = Fuel used × Heating value × Emission factor

Diesel-based CO₂ emissions = Diesel used × Heating value × Emission factor

$Diesel\text{-based } CO_2 \text{ emissions} = L/ha \times 0.0371 \text{ GJ/L} \times 74.01 \text{ kg } CO_2/GJ \dots \dots \dots (1)$

Diesel-based CO₂ emissions are measured in kg CO₂/ha.

Lubricant oil-based CO₂ emissions = Oil used × Heating value × Emission factor

$Lubricant \text{ oil-based } CO_2 \text{ emissions} = L/ha \times 0.0382 \text{ GJ/L} \times 73.28 \text{ kg } CO_2/GJ \dots \dots \dots (2)$

Lubricant oil-based CO₂ emissions are measured in kg CO₂/ha.

The value of the specific fuel consumption (*SFC*) indicates the amount of fuel consumed (L) to produce the unit quantity (t) of product.

$SFC = FC/GY \dots \dots \dots (3)$

where: *SFC* is the specific fuel consumption (L/t), *FC* is fuel consumption (L/ha) and *GY* is yield (ton/ha).

The specific seed production (*SSP*) is the ratio of fuel consumption to yield and indicates fuel consumption (L) per kg of groundnut seed.

$SSP = SP/FC \dots \dots \dots (4)$

where: *SSP* is the specific seed production (kg/L), *SP* is seed production per hectares (kg/ha) and *FC* is fuel consumption per hectares (L/ha).

The specific carbon dioxide emission (*SCO₂*) was defined to analyze the relationship between CO₂ emissions and production. The *SCO₂* is the ratio of total CO₂ emissions to groundnut yield and indicates CO₂ emissions (kgCO₂) per ton of groundnut seed.

$SCO_2 = CO_2/GY \dots \dots \dots (5)$

where: *SCO₂* is the specific carbon dioxide emission (kg CO₂/ton), *CO₂* is carbon dioxide emissions (kg CO₂/ha) and *GY* is groundnut yield (ton/ha).

RESULTS AND DISCUSSIONS

The change of production area for groundnut cultivation in Turkey between 2011 and 2016 is given in figure 1. On average over the period 2011-2016, in Turkey, groundnut has been produced on 35325.45 ha area. The average groundnut production was 129464 ton over the last five year period (Figure 2). The average groundnut yield was 3655 kg per hectare (ha) over the last five year period (Figure 3).

The change of specific fuel consumption for groundnut production in Turkey between 2011 and 2016 is given in figure 4. The specific fuel consumption for groundnut production ranged from 12.17 g_{diesel}/kg_{seed} to 14.42 g_{diesel}/kg_{seed} and the average specific fuel consumption for 5 years was determined as 13.06 g_{diesel}/kg_{seed}. For groundnut production, CO₂ emissions ranged from 3999.66 t CO₂/year to 6632.53 t CO₂/year, with a five year average CO₂ emission of 5551.3 t CO₂ per year (Figure 5).

An average of 5499.38 t CO₂/year of annual total CO₂ emissions were derived from diesel fuel consumption for production operations and 51.92 t CO₂/year from tractor oil consumption. The change of the specific CO₂ emissions for groundnut production in Turkey between 2011 and 2016 is given in figure 6.

The specific CO₂ emission for groundnut production ranged from 40.20 g CO₂/kg_{bean} to 47.81 g CO₂/kg_{bean} with an average specific CO₂ emission of 43.16 g CO₂/kg_{bean}.

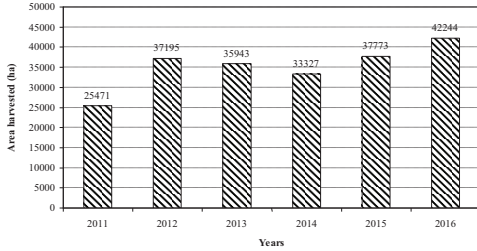


Figure 1. The change of cultivation area for groundnut production in Turkey

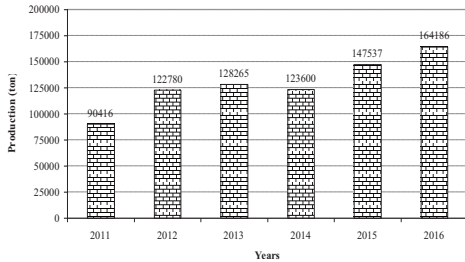


Figure 2. The change of groundnut production in Turkey

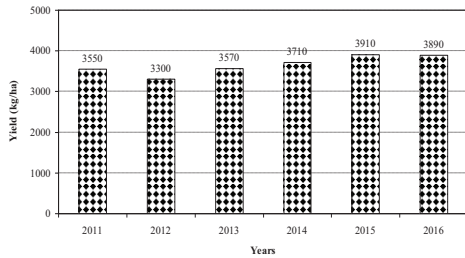


Figure 3. The change of groundnut yield in Turkey

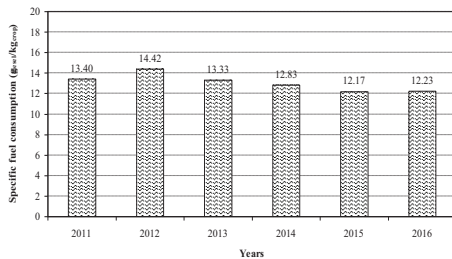


Figure 4. Change of specific fuel consumption for groundnut production in Turkey

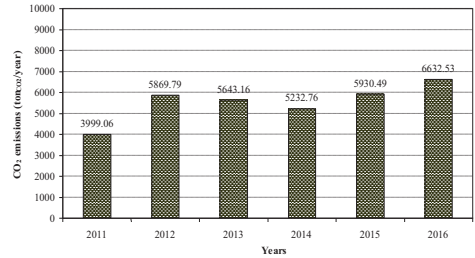


Figure 5. Change of CO₂ emissions for groundnut production in Turkey

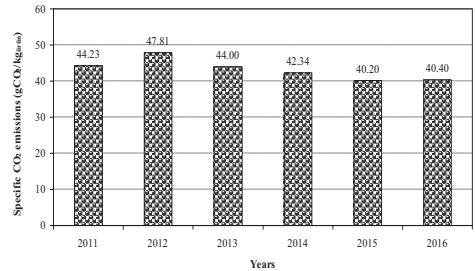


Figure 6. The change of specific CO₂ emissions groundnut production in Turkey

CONCLUSIONS

Climate change is a global problem that arises as a result of human activities. World states that have come to realize the reality of global warming in recent years have started to incorporate climate policies into sustainable development strategies, economic sectors such as energy, transport and agriculture. This shows us that more efficient use of energy can be possible, so that the same level of development can be achieved with less energy use and less emissions.

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