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Potential greenhouse gas emissions for watermelon production in Guilan Province, Iran

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Abstract

The objectives of this study was to analyze greenhouse gases (GHG) emissions for watermelon production under watered and rain fed farming in north of Iran. Data were collected from 72 farms in guilan province with face to face questionnaire method. GHG emissions can be calculated and represented per unit of the land used in crop production, per unit weight of the produced grain and per unit of the energy input or output. Results showed that, total green house gases emissions for watermelon production under watered farming was calculated as 895.16 $kgCO_{2eq}ha^{-1}$. Results showed that, total green house gases emissions for watermelon production under rain fed farming was calculated as 777.16 $kgCO_{2eq}ha^{-1}$.

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Introduction

Agriculture is a major consumer of fossil fuel energy. Primary energy consumption consists of field operations such as tillage, sowing, harvesting and transport or stationary operations such as pumping water and drying grain. Secondary areas of energy consumption are manufacturing, packing and storage of fertilizers and pesticides. Tertiary uses of energy cover activities such as acquisition of raw materials and fabrication of equipment and farm buildings (Lal, 2004). Agriculture also uses non-commercial energy, such as seed, manure and animal energy (Canakci *et al.*, 2005). Use of high yielding varieties, increased use of fertilizers and chemicals and mechanized farming are practices that consume much energy (Singh *et al.,* 2004; Tipi *et al.,* 2009). Watermelon (Citrullus lanatus) is a member of the cucurbit family (Cucurbitaceae). The crop is grown commercially in areas with long frost free warm periods (Prohens and Nuez, 2008). China, Turkey, Iran, Brazil, United States, Egypt and Russian Federation are the major watermelon producers. Iran is the 3th largest producer of watermelon in the world after China and Turkey, respectively (FAO, 2010). In 2010, Iran produced about 3466883 tonnes of watermelon in 135962 hectares; Guilan province is a one of most important watermelon producers in Iran (Moazzen, 2010). Greenhouse gases absorb infrared radiation in the atmosphere, trapping heat and warming the earth's surface, this is known as the greenhouse effect (Snyder *et al.,* 2009). Global warming is the rise in the average temperature of Earth's atmosphere and oceans since the late 19th century and its projected continuation since the early 20th century. A greenhouse gas (sometimes abbreviated GHG) is a gas in an atmosphere that absorbs and emits radiation within the thermal infrared range. GHG emissions greatly affect the temperature of the Earth (Le Treut *et al.,* 2007). With regard to global impacts, green house gases (GHG) emissions which contribute to global warming and increased level of air pollution adversely affect public and ecosystem health (Nguyen and Gheewala, 2008). Production, formulation, storage, distribution of these inputs and application with tractorized equipment lead to combustion of fossil fuel, and use of energy from alternate sources, which also emits CO_2 and other greenhouse gases (GHGs) into the atmosphere. Thus, an understanding of the emissions expressed in kilograms of carbon equivalent (kg CE) for different tillage operations, fertilizers and pesticides use, supplemental irrigation practices, harvesting and residue management is essential to identifying C-efficient alternatives such as biofuels and renewable energy sources for seedbed preparation, soil fertility management, pest control and other farm operations. Sustainable use of soil, water and other non-renewable resources implies: (i) an efficient use of all off-farm input, (ii) minimal leakage or losses through leaching, volatilization and erosion, (iii) maintenance or enhancement of soil quality and (iv) minimal risks of environmental degradation such as pollution of water and emission of GHGs into the atmosphere. Land use and land cover change and agricultural practices contribute about 20% of the global annual emission of carbon dioxide (CO_2) (Lal, 2004; IPCC, 2001).

The reduction of energy consumption is tantamount to reduction of greenhouse gas (GHG) emissions in agricultural activity. Because both items have direct relationship with input usage in agricultural activities. A further aim of the study is to determine the GHG emissions for watermelon production under watered and rain fed farming in Guilan province of Iran.

Materials and methods

Materials

Guilan Province is one of the northern provinces of Iran with an area of 14711 square meters. This province is located at 36' and 34" to 38' and 27" northern latitude and 48' and 53" to 50' and 34" eastern longitude from the Greenwich meridian. The surveyed region had homogenous conditions for orchard establishment with regards to climatic conditions, topography and soil type. The initial data were collected from watermelon orchardists using face-to-face questionnaire in the production year 2011.

Method to calculate green house gases emission

In this study, we applied the CO_2 emissions coefficient of agricultural inputs to calculation of GHG emissions (Table 1). The amount of produced CO_2 was calculated by multiplying the input application rate (machinery, diesel fuel, chemical fertilizers, chemical poison and water by its corresponding emissions coefficient that is given in Table 1 (Azarpour, 2014; Ghahderijani *et al.,* 2013; Khoshnevisan *et al.,* 2013; Nabavi-Pelesaraei *et al.,* 2013; Soltani *et al.,* 2013). The amounts of GHG emissions from inputs in watermelon production per hectare were computed by using CO_2 emissions standard coefficient of agricultural inputs (Table 3). The inputs were reasonable of GHG emissions in nectarine production including diesel fuel, machinery, chemical poison, chemical fertilizers and water. After determination of efficient and inefficient units, the GHG emissions was calculated for optimal condition and compared with regular condition (Azarpour, 2014; Ghahderijani *et al.,* 2013; Khoshnevisan *et al.,* 2013; Nabavi-Pelesaraei *et al.,* 2013; Soltani *et al.,* 2013). Greenhouse gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6), among many others. In order to compare and aggregate different greenhouse gases, various techniques have been developed to index the effect each greenhouse gas has to that of carbon dioxide, where the effect of CO_2 equals one. When the various gases are indexed and aggregated, their combined quantity is described as the CO_2-equivalent. In other words, the CO_2-equivalent quantity would have the same effect on, say, radiative forcing of the climate, as the same quantity of CO_2.

Results and discussion

The GHG emissions for watermelon production under watered farming of different inputs were calculated by using the GHG conversion factors presented in tables 1 and 2. The results revealed that, total emissions for watermelon production under watered farming was 895.16 $kgCO_{2eq}ha^{-1}$ (Table 4) from which machinery (20 h/ha= 1.42 $kgCO_{2eq}ha^{-1}$), diesel fuel (184 L/ha= 507.84 $kgCO_{2eq}ha^{-1}$), nitrogen fertilizers (195 Kg/ha= 253.5 $kgCO_{2eq}ha^{-1}$), phosphorus fertilizers (44 Kg/ha= 8.8 $kgCO_{2eq}ha^{-1}$), potassium fertilizers (6 Kg/ha= 1.2 $kgCO_{2eq}ha^{-1}$), water (1700 M^3/ha= 96.9 $kgCO_{2eq}ha^{-1}$) and chemical poison (5 L/ha= 25.5 $kgCO_{2eq}ha^{-1}$) inputs, respectively. The highest share of emissions for watermelon production under watered farming was belonged to diesel fuel with 56.73%; followed by chemical fertilizers (with 29.44%) and water (with 10.82%) (Figure 1). The lowest share of emissions for watermelon production under watered farming was belonged to machinery with 0.16%; followed by chemical poison (with 2.85%) (Figure 1).

Table 1. Amounts of physical inputs and GHG emissions coefficients of agricultural inputs.

Parameter	Unit	Quantity per Hectare (Rain fed farming)	Quantity per Hectare (Watered farming)	GHG coefficient ($kgCO_{2eq}ha^{-1}$)
Machinery	h/ha	20	20	0.071
Diesel fuel	L/ha	184	184	2.76
Nitrogen	Kg/ha	184	195	1.3
Phosphorus	Kg/ha	26	44	0.2
Potassium	Kg/ha	41	6	0.2
Poison	L/ha	3	5	5.1
Water	M3/ha	0	1700	0.057

Table 2. Amounts of GHG emission for watermelon production.

Parameter	GHG emissions (($kgCO_{2eq}ha^{-1}$) (Watered farming)	GHG emissions ($kgCO_{2eq}ha^{-1}$) Rainfedfarming)
Machinery	1.42	1.42
Diesel fuel	507.84	507.84
Nitrogen	253.5	239.2
Phosphorus	8.8	5.2
Potassium	1.2	8.2
Poison	25.5	15.3
Water	96.9	0
Total	895.16	777.16

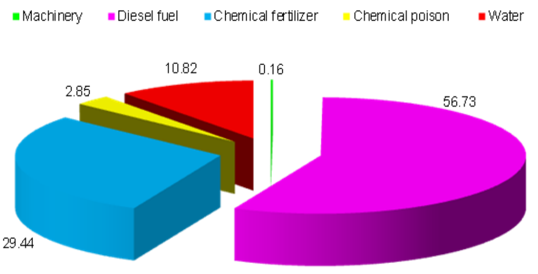

Fig. 1. The share of each input for GHG emission reduction of watermelon production in watered farming system.

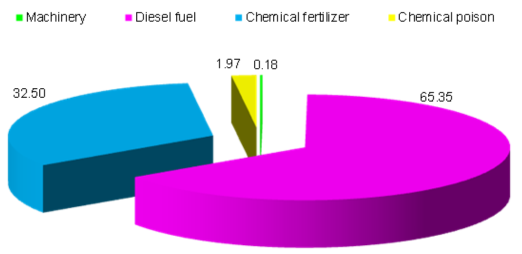

Fig. 2. The share of each input for GHG emission reduction of watermelon production in rain fed farming system.

The GHG emissions for watermelon production under rain fed farming of different inputs were calculated by using the GHG conversion factors presented in tables 1 and 2. The results revealed that, total emissions for watermelon production under rain fed farming was 777.16 $kgCO_{2eq}ha^{-1}$ (Table 4) from which machinery (20 h/ha= 1.42 $kgCO_{2eq}ha^{-1}$), diesel fuel (184 L/ha= 507.84 $kgCO_{2eq}ha^{-1}$), nitrogen fertilizers (184 Kg/ha= 239.2 $kgCO_{2eq}ha^{-1}$), phosphorus fertilizers (26 Kg/ha= 5.2 $kgCO_{2eq}ha^{-1}$), potassium fertilizers (41 Kg/ha= 8.2 $kgCO_{2eq}ha^{-1}$) and chemical poison (3 L/ha= 15.3 $kgCO_{2eq}ha^{-1}$) inputs, respectively. The highest share of emissions for watermelon production under rain fed farming was belonged to diesel fuel with 65.35%; followed by chemical fertilizers (with 32.50%) (Figure 2). The lowest share of emissions for watermelon production under rain fed farming was belonged to machinery with 0.18%; followed by chemical poison (with 1.97%) (Figure 2).

Conclusion

The objective of this study was to predict GHG emissions for watermelon production under watered and rain fed farming on the basis of energy inputs. Results showed that, total green house gases emissions for watermelon production under watered farming was calculated as 895.16 $kgCO_{2eq}ha^{-1}$. Results showed that, total green house gases emissions for watermelon production under rain fed farming was calculated as 777.16 $kgCO_{2eq}ha^{-1}$.

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