Evaluation of environmental effects in producing three main crops (corn, wheat and soybean) using life cycle assessment

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Abstract: Currently, environmental pollution and greenhouse gases emissions are both challenges of the human society that have attracted the attention of many countries, scientists and researchers. To control and reduce the environmental pollution, it is necessary to track the environmental impact during the production of the desired product. Therefore, the agricultural industry required an appropriate policy management to reduce the environmental impacts for the production process with less impacting. LCA approach specifies the environmental impact during the production of the interest product. In addition, corn, wheat and soybeans are among the top 10 products in the world. Therefore, producing these crops according to the type of production system, the rate of inputs consumption, and also the identified negative impact on environment during planting, are essential for the proper management of resources. The collected data were analyzed and the necessary information for the system input was obtained, the data was imported to the SimaPro software. According to the obtained results, the amount of acidification and photochemical oxidation indicators for wheat, corn and soybean were calculated to be 16.7, 14.9, 6.6 kg SO_2 eq and 0.715, 0.634, 0.359 kg C_2H_4 eq, respectively. Therefore, the results showed that the maximum amount of acidities and photochemical oxidation were from wheat. Also, in another environmental indicators, the soybean product showed the maximum amounts. Finally, to reduce environment impacts of production, some solution has been provided for resource consumption management.

Keywords: environmental impacts, SimaPro, greenhouse gases, acidification, photochemical oxidation

Citation: Ghasempour, A., E. Ahmadi. 2018. Evaluation of environmental effects in producing three main crops (corn, wheat and soybean) using life cycle assessment. Agricultural Engineering International: CIGR Journal, 20(2): 126–137.

1 Introduction

Increasing industrial activities, transportation, agriculture, ranching, etc., in the world, caused global warming and increased the greenhouse gases emission (Mitchell, 2003), which is now the problem of climate changing phenomenon. Global warming draws the attention of many scientists as a result of greenhouse gas emission, because this issue had put the world at the threshold of a human and environmental great disaster. According to the Intergovernmental Panel on Climate Change (IPCC, 2006), the main greenhouse gases includes CO_2, N_2O, and CH_4, which caused the warming of the earth atmosphere. If this trend of climate changes tends to continue, they will face many changes in earth situation in near future. In recent years, the activity of agricultural industry has been increased substantially as improving production methods, the wide application of fertilizers and pesticides, and the development of animal husbandry industry, which have caused an increase in the production, but these increases and wide use of inputs also lead to many environmental problems (OECD, 2001; Birkved and Hauschild, 2006; Van der Werf and Turunen, 2008).

Since agricultural and animal husbandry productions lead to the associated maximum production of greenhouse gases, thus, agricultural industry should improve the emission intensity of greenhouse gases by suitable policy management in environmental resources and effects (Nemecek et al., 2008). Therefore, the production of corn, wheat and soybean in agriculture

Received date: 2017-10-07 **Accepted date:** 2018-03-05

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industry and poultry in terms of type of cultivation, the rate of inputs consumption including application of fertilizers and pesticides and other farming processes, will leave a negative impact on the environment. Recognition and evaluation of these environmental impact in the production system will lead to the achievement of sustainable development goals, which will be achieved by LCA (Life Cycle Assessment) (Hatirli et al., 2005).

LCA, as an international standard method, is able to support analyses of input and output emissions from production system proportional to the life cycle of crops or processes, and is taken into environmental experts for consideration. Based on the standard definition of ISO 14040, LCA investigates environmental aspects and environmental potential throughout the life cycle of a crop or one step of processed raw material to production (consumption, end of biological practices, recycling and final disposal). Based on this standard, the LCA contains four portions including the express purpose, determining inputs and outputs of the system, evaluating environmental impacts and their interpretation (ISO 14040, 2006).

The results of a study on the environmental problems resulting from the use of different levels of chemical nitrogen fertilizer in producing wheat in Germany showed that eutrophication which was the most important environmental impacts in wheat production, would be increased by increasing the use of nitrogen fertilizer. The results of this study suggested that, the most common environmental impacts were acidities indicators and global warming impacts for producing one-ton wheat (Brentrup et al., 2004; Khoshnevisan and Rafiee et al., 2014).

Ghosh (2004) investigated the impacts of manures replacement rather than chemical fertilizers in producing rice and peanut in India. He believes that overuse of chemical fertilizers during the green revolution in India, besides imposing a heavy financial burden on state budget, caused some damages to the quality of soil. Thus, this technology was not suitable for the developing agricultural sector and its replacement with manures was suggested (Mohammadi et al., 2013).

Agricultural sector had been allocated about 40% of total emissions of N_2O, which has been set as an important sector of energy consumption in Iran, while the share of the agricultural sector is 2% in emission of two other gases CO_2 and CH_4 (Anonymous, 2008). The result of investigations showed that agriculture had the high share in the emission of greenhouse gases, thus environmental management was important in production systems for diagnosis of some points of production stage which caused the most environmental impacts and greenhouse gases production on environment, this would lead to a decrease in environmental charge in the production system.

Goal definition and scoping are the first stage of a LCA study. The purpose of running this research is to specify environmental effects during production of three crops: wheat, corn and soybean. Secondary objective is to compare the emission rate of these gases, specifying the main factors in environmental indexes, and also to present management approaches in order to reduce environmental effects and emissions.

2 Materials and methods

2.1 Study area

Alborz province was considered as studied area for two crops including corn and wheat, the extent of this province is 5833 km^2 and is located in Alborz mountain range and has a mild climate. The average of annual temperature is 16ºC and its height above sea level is 1300 m. From a long time ago, this place was counted as cradle of Iran agriculture. Cultivation of wheat and corn has been announced 10,000 and 4,000 hectares, respectively based on the Jahad agriculture statistics of Alborz province (Anonymous, 2013a).

Golestan province was considered as the studied area for soybean with its extent is 20637 km^2. This province is located in the northeast of Iran, between 36º and 30' to 38º and 8' of north latitude and 53º and 57' to 56º and 22' east latitude. The average of annual temperature and the amount of rainfall has been recorded 17.7 ºC and 412 mm respectively. Soybean cultivation has been announced about 53,000 hectares based on the Jahad agriculture statistics of Golestan province (Anonymous, 2013b).

2.2 Life cycle assessment

LCA is a technique for assessing the environmental aspects and impacts of products, activities and services along the life cycle from extraction of raw materials, through processing, manufacturing, distribution, use, and on to final waste management (Sonesson et al., 2010). Thus, we should select the software based on how it works and its requirement in this project. Price should never be the sole deciding factor, but it must be weighed as a variable alongside the utility of the product. Different types of LCA software include: SimaPro, GaBi, Quqntis Suite, EarthSmart, Sustainable Minds, Enviance System, Link Cycle Footprint. We selected the SimaPro software based on the work mthod and demands of the project. SimaPro was used because it is a highly used piece of LCA software; SimaPro is thoroughly tested and robust. As well, its popularity makes SimaPro's findings and reports easy to share with colleagues. The hardware and software requirements for running this program are also fairly light (Herrmann and Moltesen, 2015).

2.3 Description of cultivation

2.3.1 Farm operations in wheat production

Preparation of land is very important for increasing the wheat yield. Wheat cultivation within the study area was categorized into three main steps: Soil tillage, planting and harvesting. Land preparation employs a set of moldboard plow and disk plow for plowing practices to get rid of weeds and prepare the physical condition of the soil for planting, including low leveling of the soil surface. Then the planters were used for the cultivation of wheat. The rotary cultivator was also used to eliminate weeds and break the soil crust. Finally, the combine wass used for harvesting.

2.3.2 Farm operations in corn production

Firstly, to prepare land for corn cultivation, plowing was performed at 30 cm depth in autumn, which leads to a better preparation of the bed in spring, again another plowing was done to the depth of 30 cm against previous plowing in spring. Then the earth was left for 3-10 days for more reduction of soil moisture depending on the climate condition. Then two perpendicular light disks have been used for crushing clods and soil softening. Also, rotivator machine has been used for better crushing clods, corn wet planting was preferred to the corn dry planting to have a soft and uniform particularly in heavy soils and preventing of crust formation. Harvesting of this crop was done by combination.

2.3.3 Farm operations in soybean production

Soybean is a summery plant, which is cultivated according to the type of varieties and climate condition of area in the mid-spring to early of summer. To prepare land and cultivation, plowing the land in a semi-depth manner has firstly been done by using disk and then flatting the land by using of a cultivar and leveler, and then attempt to fertilizing and distributing herbicides steadily on the farm, and mixing fertilizer and herbicide by the light disk. When 90% of soya's pods turn to the ripe color, it was time to harvest the farm in a mechanization manner.

2.4 Functional unit

The scope of a LCA study shall clearly specify the functions of the system being studied. A functional unit is a measure of the performance of the functional outputs of the product system. The primary purpose of a functional unit is to provide a reference that the inputs and outputs are related (Guinée et al., 2002). This reference is necessary to ensure comparability of LCA results. Comparability of LCA results is particularly critical when different systems are being assessed to ensure that such comparisons are made on a common basis. Thus, the functional unit is defined as the quantified performance of a product system for use as a reference unit. It is an expression of the service provided by the product system (Sonesson et al., 2010). In this study, the inputs, required at a level of one hectare used for crop production, was firstly entered into the software and then the outputs was based on the production of a ton of products.

2.5 System boundary

After defining the functional unit, the next step is to give the definition of the system boundary to identify which unit processes are included in the LCA and which are not. The definition of system boundaries is important for designing an LCA and theoretically it should include as completely as possible all unit processes necessary for delivering the functional unit (Sonesson et al., 2010).

According to Figure 1, system boundary in this study, considered separately as cultivation farm of each one of three products wheat, corn and soybean, and for each farm, the average of consumption inputs including machinery, the amount of seed, fertilizer, pesticide, electricity, fuel, etc. were calculated for one hectare.

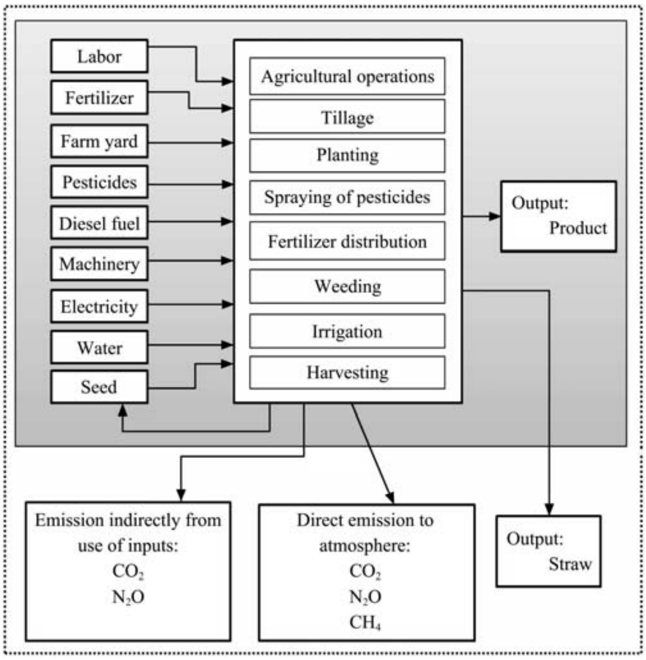

Figure 1 System boundary of seed production

2.6 Life cycle inventory (LCI)

The data of this study were collected by questionnaire and interviews, and the input information includes consumption of fuel, electricity, water, fertilizer, etc. and the details of cultivating each product were given in Table 1 for cultivating products.

Table 1 Life cycle inventory data for corn, wheat and soybean cultivation (per one ha)

Inputs	Unit	Corn	Wheat	Soybean
		Land based	Land based	Land based
Machinery weight	kg	144.79	138.95	130.28
Labor	h	284.91	246.7	219.66
Diesel fuel	L	196.8	193.5	186.853
Water	m^3	3271.55	2961.58	2197.935
Electricity	kWh	3969.25	3680	888.367
Nitrogen (N)	kg	139.08	134.12	67.72
Phosphate (P_2O_5)	kg	76.36	78.64	48.16
Potassium (K_2O)	kg	12.99	48	12
Farmyard manure	kg	5000	4000	3800
Pesticides & Herbicides	kg	2.43	3.69	3.11
Seed	kg	25	200	65

Inventory analysis, which involves data collection and calculation procedures to quantify the relevant inputs, outputs and emissions from a product system. Inputs comprise the use of resources (e.g. fossil fuels, minerals, water and land) and outputs are the products/co-products produced by the processes involved.

Environment pollutants from the cultivation step include the emissions to air, water, and soil from the field. Emissions to water include substances that leave the root zone of the plants, such assurplus nutrients not assimilated by the crop and harvested. In calculating N-related emissions, for example, the starting point is an N-balance on the field scale. Known inputs and outputs related to seed, fertilizer, changes in N in soil matter and harvested crop and straw are balanced in order to determine the N surplus. This surplus is then distributed across the different emissions (Khoshnevisan and Rajaeifar et al., 2014).

The most important environmental N emissions are ammonia (NH_3), nitrous oxide (N_2O) and nitrate (NO_3). The emission rates are variable due to the influence of soil type, climatic conditions and agricultural management practices. Instead of measurements, structured methods can be used to estimate average emission rates (Brentrup et al., 2000).

2.7 Chemical fertilizer

Chemical fertilizers referred to the material which has one or more essential element for nutrition and growth and development of plants. Plants growth required sufficient and balanced amount of elements in soil. Balanced supply and required elements of plants to gain maximum quality and quantity of products called fertilizing which, their shortage is observed in soils by directly adding elements. Fertilizers and chemical materials are used widely in agriculture and have many direct and indirect emissions.

Soil N_2O emissions were simulated for different scenarios of climate, fertiliser rate, type and management and they contribute to the global warming potential category. Indirect N_2O emissions from NO_3 and NH_4 were also considered and estimated according to IPCC (2006) which assume that a fraction of the N leached, volatilised or emitted as N oxides will be eventually lost as N_2O. For calculating and estimating the amount of direct and indirect emission of nitrous oxide to air, following equations were used. In this study, the following equations were used to calculate and estimate the rate of direct and indirect N_2O to air (IPCC, 2006):

$$N_2O\text{ (direct)} = (44/28)\times[0.01\times(F_{SN}+F_{ON}+F_{CR}+F_{SOM})] \quad (1)$$

$$N_2O\text{ (indirect)} = (44/28)\times0.01\times[(0.1\times F_{SN})+0.2\times(F_{SN}+F_{PRP})] \quad (2)$$

where, F_{SN} = annual amount of synthetic fertilizer N applied to soils, kg N yr^{-1}; F_{ON} = annual amount of animal manure, compost, sewage sludge and other organic N additions applied to soils, kg N yr^{-1}; F_{CR} = annual amount of N in crop residues (above-ground and below-ground), including N-fixing crops, and from forage/pasture renewal, returned to soils, kg N yr^{-1}; F_{SOM} = annual amount of N in mineral soils that is mineralized, in association with loss of soil C from soil organic, kg N yr^{-1}; F_{PRP} = matter as a result of changes to land use or management annual amount of urine and dung N deposited by animals on pasture, range and paddock, kg N yr^{-1}.

2.8 Toxins

Pesticide consumption in crops which is mentioned above is used as herbicides and pesticides. To determine the amount of pollutant emissions in hectare, type determination, percentage of effective substance, and the amount of pesticide per hectare were calculated and recorded according to the recorded information of farmers in questionnaires.

2.9 Fuel

Fuel consumption required is affected by different factors, such as climate, soil type, depth of tillage, volume of disturbed soil, type of the land and travel speed of mechanical tools in the farm. Diesel fuel is used for preparing the land to cultivate, cultivation operations, planting and harvesting operations. The average of fuel consumption is calculated in terms of L kg^{-1} and then is converted to MJ L^{-1}, and the amount of diesel fuel emission is calculated according to the factors of EcoInvent, and then is entered within the software.

Based on the values presented in Table 2, it is apparent that EcoInvent includes more categories of emissions than LCA food, but for most categories the amounts in LCA food are higher than those of Ecoinvent.

2.10 Life cycle impact assessment

Life Cycle Impact Assessment (LCIA) is the phase in which the set of Inventory analysis is further processed and interpreted in terms of environmental impacts and societal preferences. The actual modeling results are calculated in the characterization step, and an optional normalization serves to indicate the share of the modeled results in a regional total. Finally, the category indicator results can be grouped and weighted to include societal preferences of the various impact categories.

Table 2 Comparison of life cycle inventory data for 1 MJ traction I Ecoinvent and LCA food

Emission	Amount (g MJ^{-1} diesel)	
	Ecoinvent	LCA food
Carbon dioxide (CO_2)	74.5	87
Sulfur dioxide (SO_2)	2.41E-02	2.50E-02
Methane (CH_4)	3.08E-03	4.10E-03
Benzene	1.74E-04	-
Cadmium (Cd)	2.39E-07	-
Chromium (Cr)	1.19E-06	-
Copper (Cu)	4.06E-05	-
Dinitrogen monoxide (N_2O)	2.86E-03	9.10E-03
Nickel (Ni)	1.67E-06	-
Zink (Zn)	2.39E-05	-
Benzo(a)pyrene	7.16E-07	-
Ammonia (NH_3)	4.77E-04	-
Selenium (Se)	2.39E-07	-
PAH (poly cyclic hydrocarbons)	7.85E-05	-
Hydro carbons (HC, as NMVOC)	6.80E-02	1.17E-01
Nitrogen oxides (NO_x)	1.06	1.10
Carbon monoxide (CO)	1.50E-01	2.80E-01
Particulates (<2.5 μm)	1.07E-01	7.10E-02

For obtaining life cycle impact assessment in SimaPro software, we have to use models (BEES, CML, CULUMATIVE ENERGY DEMAND, ECO-INDICATOR). In this research, CML-IA baseline V3.001/EU25 is used which developed by Center of Environmental Science (CML) of Leiden University in the Netherlands and this model commonly used in LCA studies of agricultural production (Heijungs et al., 1992).

The SimaPro software stored primal information in database. Finally, to calculate the environmental indicators were selected as a model among models within the application that are listed with description and History and use cases. To calculate environmental indicators (warming potential, acidification, Eutrophication, toxicity, etc.) crops and livestock was used CML-IA baseline V3.01/EU25 model.

One of most important and necessary proceedings in LCA study is choosing the systems boundary and was used to determine which activities present in LCA study. The life cycle assessment is cradle to grave attitude but there is possibility in order to more concentrate on processes, the system boundary has considered as a part of the whole process and the results has selected based on boundary and expressed for a smaller scale (Khoshnevisan and Rafiee et al., 2014; McDougall, 2001).

Finaly, data collected was entered in each stage of production separately and eventually the rate of environmental indicators (the potential of global warming, acidification, climate changing, poisoning etc.) were determined in each stage separately. The ten impact categories of this methodology include: Global Warming (GW) potential for time horizon 100 years, Ozone Depletion (OD) potential, Abiotic Depletion potential (AD), Acidification potential (AC), Eutrophication potential (EU), Human Toxicity (HT) potential, Freshwater and Marine Aquatic Ecotoxicity potential (FAET and MAET), Terrestrial Ecotoxicity (TE) potential, and Photochemical Oxidation (PhO) potential (Khoshnevisan and Rajaeifar et al., 2014b).

(1) Natural resources depletion (abiotic): This potential consists of the consumption of renewable resources and non-renewable resources (such as wind, water stream). The resource consumption without ensuring of renewal leads to exhaustion quickly (Goedkoop et al., 2008).

(2) Fossil resource depletion: This environmental indicator, related to the exploitation of mineral resource and fossil fuels and also the potential of fossil resource depletion, exploitation of mineral resource and fossil fuels remain the base of resources and it determined the exploitation rate (Goedkoop et al., 2008).

(3) Global warming: The potential of global warming GWP is the potential share of one material in greenhouse impact (Goedkoop et al., 2008).

(4) The ozone layer depletion: The ozone layer potential (ODP) and the value of ozone layer destruction which is its major created by hydrocarbons including Carbon, Fluorine and Chlorine (CFC) has showed (PRé Consultants, 2003).

(5) Human toxicity: When the human toxicity potential (HTP) is calculated, it’s indicated of the damage potential of one unit of released chemical material to environment base on toxicity of a combination and its potential of consumption dose (PRé Consultants, 2003).

HCA: The human toxicological classification value of for air.

HCW: The human toxicological classification value for water.

(6) Fresh-water aquatic eco-toxicity: This category indicator refers to the impact on fresh water ecosystems, as a result of emissions of toxic substances to air, water and soil. Fresh-water aquatic eco-toxicity potential (FETP) are calculated with USES-LCA, describing fate, exposure and effects of toxic substances. The time horizon is infinite characterization factors, which are expressed as 1.4-dichlorobenzene equivalents/kg emission. The indicator applies at global/continental/regional and local scale (Goedkoop et al., 2008).

(7) Marine eco-toxicity: Marine eco-toxicity refers to impacts of toxic substances on marine ecosystems (PRé Consultants, 2003).

(8) Photochemical oxidation: photochemical oxidation is the second pollution of weather also has recognized as summer smog. The photochemical potential has showed the creation of the 1 capacity of ozone of volatile organic material for ozone production (Goedkoop et al., 2008).

(9) Acidity: The acidity potential (AP) shows the acidification impact of SO_2. Another material which has been recognized as acidification, nitrogen oxide and ammonium. The impact of SO_x is also similar to SO_2 (PRé Consultants, 2003).

(10) Eutrophication: The eutrophication potential was used based on PO_4^{-2}, another emissions of eutrophication were nitrogen oxidation N_2O and ammonium NH_4^+ (Goedkoop et al., 2008).

3 Results and discussion

The environmental indicators of three crops including corn, wheat and soybean are calculated and the results are shown to produce a ton of product in Table 3.

Table 3 The environmental effective indexes of corn, wheat and soybean (per one tonne)

Impact category	Unit	Corn	Wheat	Soybean
Abiotic depletion	kg Sb eq	0.0034	0.0044	0.0062
Abiotic depletion (fossil fuels)	GJ	6.01	7.45	8.43
Global warming (GWP100a)	kg CO_2 eq	999.3	1088.6	1480.9
Ozone layer depletion (ODP)	kg CFC-11 eq	2.05E-05	3.06E-05	4.86E-05
Human toxicity	kg 1,4-DB eq	169.6	203.1	304.8
Fresh water aquatic ecotox.	kg 1,4-DB eq	122.2	144.3	196.4
Marine aquatic ecotoxicity	kg 1,4-DB eq	356,398	425,514	592,311
Terrestrial ecotoxicity	kg 1,4-DB eq	2.15	2.51	2.71
Photochemical oxidation	kg C_2H_4 eq	0.634	0.715	0.359
Acidification	kg SO_2 eq	14.9	16.7	6.6
Eutrophication	kg PO_4 eq	1.26	1.41	2.05

The magnitude of indicators of Abiotic depletion, Human toxicity, Fresh water aquatic ecotoxicity, Marine aquatic ecotoxicity, Terrestrial ecotoxicity, and Eutrophication were more than two other farming crops in producing soybean according to the Table 3 and Figure 2. This is due to the type of the product and the more use of inputs relative to the product performance in the region of interest. Toxicity, caused through the breathing in air around in humans, lead to a throat irritation, skin allergies and swelling of the eyes in short term and affect on skin, liver and human neural system in long term. Furthermore, the role of available sub-systems has been determined according to the Figures 3, 4 and 5 which is important for these environmental indicators in production.

According to Table 3, the rate of global warming (GWP), which were the environmental effective indicators in producing corn, wheat and soybean, were shown as 999.3, 1088.6, and 1480.9 kg CO_2 eq t^{-1}, respectively. As it can be seen, soybean has more impact on the emission of this indicator than two other crops. Two effective factors were consumption of electricity inputs and nitrogen fertilizer for wheat and corn in this indicator, according to Figures 3 and 4. The effective factors for soybean were the use of agricultural machinery and diesel fuel according to Figure 5.

Mirhaji et al. (2012) argued that the rate of global warming emission in wheat production was 262.09 kg CO_2 eq in Fars Province, which N_2O and CO_2 were the most effective gases in creating this impact which caused by consumption of urea fertilizer.

Mohammadi et al. (2014) obtained the indicator of global warming potential (GWP) as 1840.8 kg CO_2 per tonne for wheat, and argued that the most important factor in this indicator was diesel fuel and chemical fertilizer.

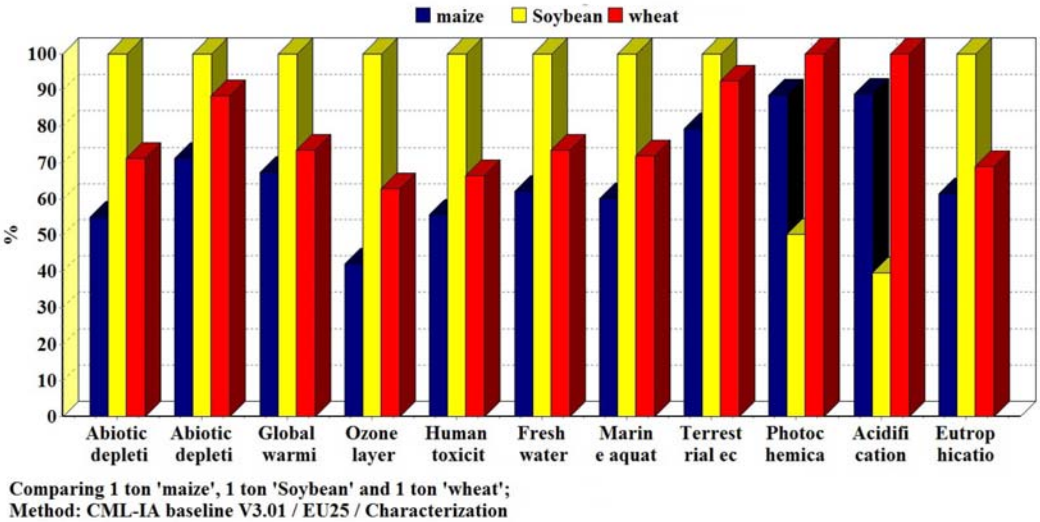

Figure 2 Comparison of the effective indexes of corn, wheat and soybean

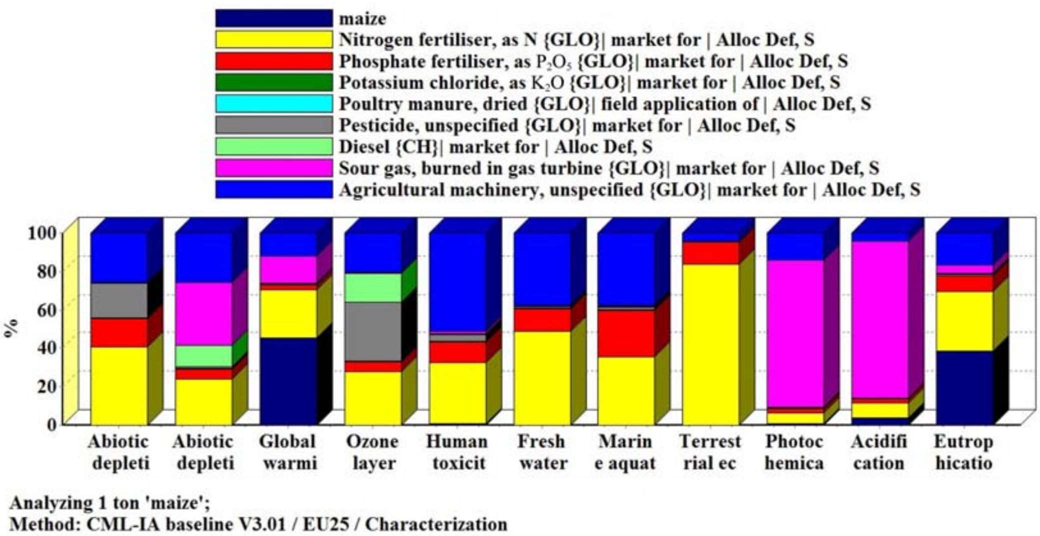

Figure 3 The Share of inputs effect on the effective indexes in maize

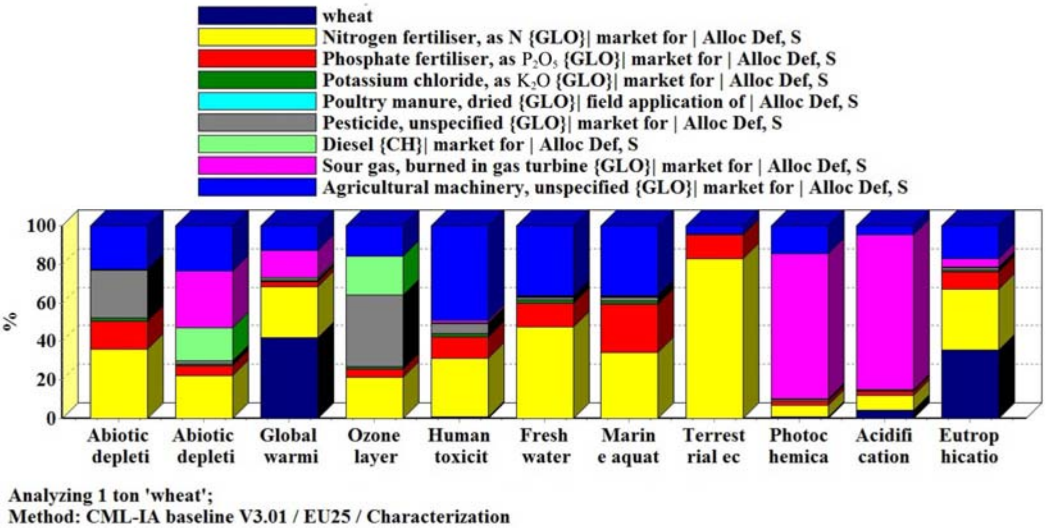

Figure 4 The Share of inputs effect on the effective indexes in wheat

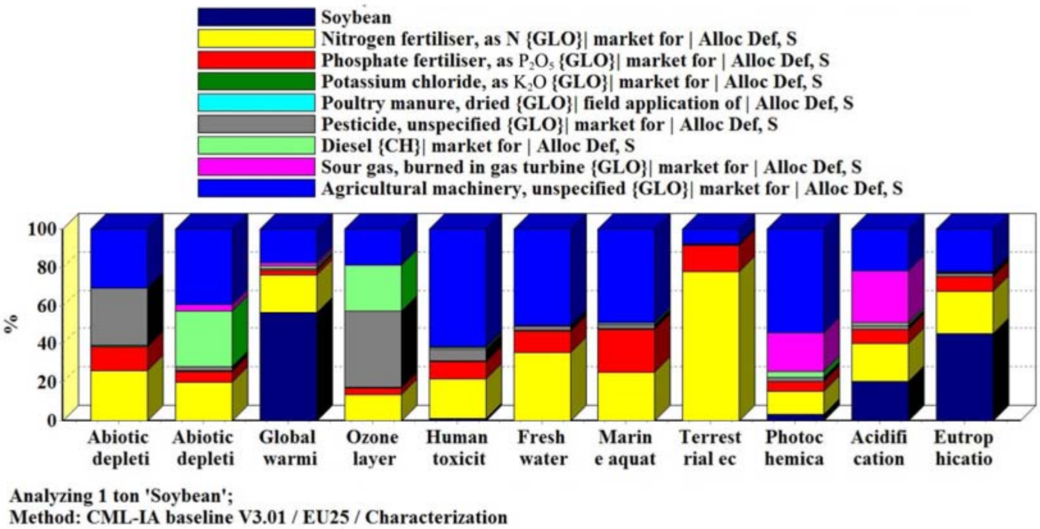

Figure 5 The Share of inputs effect on the effective indexes in soybean

Most LCA studies on wheat production revealed that reducing fertilisers below optimum levels led to the increasing of global warming potential and several other impacts (Kulak et al., 2013).

Roer et al. (2012) demonstrated that, CO_2 (59%) and N_2O (39%) gases had the highest share in spring wheat cultivation among other greenhouse gases in south east of Norway. Among effective inputs in producing greenhouse gases, chemical fertilizers production showed the highest share for all investigated environmental indicators, so that, its share was estimated about 30% for producing spring wheat.

The rate of the Ozone layer indicators of soybean was more than corn and wheat, the most effective inputs, were consumption of nitrogen fertilizer and pesticide in wheat and cornand were consumption of pesticide and diesel fuel in soybean production.

The rate of Photochemical oxidation indicators was more in producing wheat, corn and soybean respectively, which was the most important reason of producing these indicators, and was electricity consumption in corn and wheat production, and using agricultural machines for farming processes in soybean product.

The maximum amount of acidities indicator belongs to wheat, corn and soybean and calculated to be 16.7427, 14.8964, 6.6459 kg SO_2eq respectively. The maximum amount was related to wheat which wasthe most effective factor in the rate of this indicators for its production was electricity consumption.

Furthermore, according to the rate of environmental indicators in Figures 3, 4, 5, the most inputs which is affect in the rate of these indicators are nitrogen fertilizer consumption, electricity consumption, using farming machinery, diesel fuel and pesticides consumption. Thus, some management approaches should be presented for reducing these indicators.

3.1 Fertilizer consumption management

There is a common belief among Iranian farmers that overusing of chemical fertilizers and more irrigation will lead to increase the product performance and thus the profit will be increased. Furthermore, many farmers attempt to consume total required nitrogen fertilizer when it is the time for planting. Some of them use the total amount of consumption fertilizer twice, one during cultivation time and another used in spring. While nitrogen fertilizer is so volatile and will immediately come out of the reach of plant (Mohammadi et al., 2013). In addition to loss of much energy which is used for producing and applying fertilizer, using fertilizer in one time and during the cultivation time will cause many negative environmental aspects. Thus, reducing the rate of consumption of these fertilizers or replacing them with other resources of nitrogen (green manure, or better use of fixed nitrogen of N air or using compost), can improve environmental aspects of wheat production.

The used resource for nitrogen supplying, should be consistent with product requirement and agricultural soils, also we can use accurate agricultural techniques for management of fertilizer consumption.

In addition to the mentioned above, crop residue management is another factor which affects the rate of greenhouse gases emissions. In many farms under study, plant residues are burned, some of the farmers attempt to harvest the plant residues in order to use them for animal husbandry feed. Burning plant residues in farms are considered as the main factor of greenhouse gas emission, especially in developing countries like Iran. Although this statement is not associated with great uncertainty and needs more and exact information in this regard (Zhang et al., 2013).

The low price of straw is one of the reasons that farmers have no motivation for collecting plant residues from their farms and attempt to burn them. The plant residues can also be used as bio-energy resource.

Burning plant residues are also known as an injurious factor for human health, especially for children and youths who are severely sensitive against air pollution (Agarwal et al., 2012).

As a result, consumption management of chemical fertilizer, particularly nitrogen fertilizer is very necessary in the region. Replacement of different alternation systems and placing plants which can fix biologically nitrogen available in atmosphere in soil instead of single-cultivation systems can be very useful in this alteration. Gallejones et al. (2015) simulated N_2O emissions coincided when applying ammonium nitrate fertiliser in the crops' production. It was resulted in the highest N lost by leaching while N losses by NH_3 volatilisation were the lowest. Bouwman et al. (2002) showed a linear relation between N_2O emissions and fertiliser rates.

3.2 Machinery and diesel fuel management

In most farms in the region, using traditional tillage methods are along with restoring full soil, and high energy consuming is common. The depth plowing needs high traction power which is very energy-intensive, although, the performance was not increased by the increasing depth of tillage. (Pimentel, 1991). Tillage is associated with emission of CO_2, because fossil fuels are used directly in agriculture tractors as well. Furthermore, producing and supplying fuel and agriculture machinery will cause the emission of greenhouse gases in farms (West and Marland, 2002). Smith et al. (1998) reported that changing tillage method could lead to the decomposition of carbon (C) in agriculture soils and could reduce the amount of greenhouse gases emission to the atmosphere.

Kern and Johnson (1993) estimated that the emission of carbon (C) which was along with conventional tillage, reduction tillage, no-tillage, was equal to 52.8, 41.0, 29.0 kg ha^{-1} per year, respectively. Using reduction tillage method or no-tillage method in addition to increasing energy efficiency could reduce the amount of greenhouse gases emission due to the decreasing of mechanizing operations.

Spugnoli and Dainelli (2013) suggested that the switch from mechanical traction to animal draft power in a developed country increased the primary energy consumption and the Global Warming potential per unit of cultivated area. Breiling et al. (2005) investigated the potential of no-tillage method in reducing the rate of greenhouse gases emission through the life cycle assessment. They reported that applying machines, fertilizers, pesticides, and diesel fuels by exploitation systems of cooperatives company, and more importantly, using combine machines or combinants, could reduce the emission of greenhouse gases and environmental damages in Japan.

In many studies, it has been reported that the consumption of fossil fuels is the main factor of greenhouse gases emission (West and Marland, 2002; Liu et al., 2010).

In the research of Rajabi et al. (2010) in the north of Iran, the amount of fuel was obtained between 53-123 L ha^{-1} for wheat. They declared that reducing or unifying different farming operations (such as protective tillage methods) would lead to the decreasing of fuel consumption. Another factor which was more affected on gasoil consumption is the life time of agriculture machinery, according to the statistics, 62% of the total agricultural tractors have more than 10-12 years life time in Iran. Further more, the worn out combines in the country are 3840 machines (Anonymous, 2011). Mirhaji et al. (2012) also showed in a study that the worn-out tractor led to the increasing of fuel consumption to 3 liter per hours. It is better to use the supplies and equipment which has lower consumption and the old and merged equipment must removed from the inside of farms.

3.3 Electricity management

In the studied region, electricity is used for irrigation and pumping water in many farms. Some farmers use traditional methods of irrigation which caused wasting a lot of water and revealed the need to use of modern methods of irrigation to prevent the loss of water and to reduce the greenhouse gases emissions. Schlesinger (1999) obtained 220-830 kg of CO_2 ha^{-1} in emission resulting of irrigations. Follet (2001) calculated the rate of greenhouse gas emission resulting from pumping systems in irrigation, 150-200 kg of CO_2 ha^{-1} by the energy resource used in it.

However, natural gas is the major resource to product electricity energy in Iran, and until 2010, total fuels consumption was some of the inputs for generating electricity and electrical energy as well which is received subsidy from government. All along, the cost of electricity was very lower than its real price. The low price of electricity energy can be the factor for increasing the emission of greenhouse gases (Mousavi-Avval et al., 2012). But since 2010 onwards, all these subsidies allocated to the inputs of electricity energy production were omitted gradually. This means that in the near future, electricity and fossil fuels will be available to its real price. In this condition, more investment and development of renewable energy resources, especially biomass energy in agriculture, can be in priority. Therefore, using biomass resulting from plant residues to produce electricity can be an option for reducing the consumption of electrical energy and emissions of greenhouse gases (Lal et al., 2004).

3.4 Pesticide management

It is necessary to calibrate the spraying machine outside the farm to reduce the consumption pesticide, also it can control consumption pesticide by using biological control method, and only 25% of farmers use compilation method (chemical and biologic challenging combination) based on the collected information from farmers. In the study which is done by Hosseinzade et al. (2010) on economic analysis of environmental benefits of integrated pest management (IPM) programs in south of Iran, it was determined that pesticide consumption had been decreased to 2% using by integrated management method of pests and plant pathology. It seems that using training-promotion and protection methods in order to encourage the farmers to use the biological challenging were more than before, as well as more attention of administrative organization especially, time of releasing these beneficial insect can be effective and beneficial in this regard. According to the investigation in this field, it should get benefit of no-tillage, low-tillage, and harvester machine in producing of agriculture products and also it could use the modern method of irrigation and struggling with pesticide.

4 Conclusions

Soybean production in comparison with corn and wheat has the maximum amount of energy consumption, which as a result, has the greater environmental burdens. Fuel consumption and agricultural machinery are two main reasons for the high amount of energy in soybean production. In this research, nitrogen fertilizer consumption, electricity consumption, using agricultural machinery, diesel fuel and pesticide consumption were the most important effective factors of environmental impacts. To reduce these inputs such as nitrogen fertilizer, the used resource for nitrogen supplying, should be selected according to the production and agricultural soil requirement. In fuel managing, the farmer should reduce or compound different farming operations (such as conservation tillage methods) to decrease fuel consumption. Also, they need to use modern irrigation methods in order to prevent wasting water and reducing the emission of greenhouse gases to reduce electricity consumption. Finally, the farmers should use biological and integrated methods of extermination for pesticide consumption management to reduce the environmental indicators.

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