Biological Forum – An International Journal **7**(1): 115-118(2015)

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Optimization of Greenhouse Gas Emissions for Barley Production in Guilan Province (Iran)

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(Received 10 November, 2014, Accepted 14 January, 2015)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: In a world with an increasing urban population, analysing the construction impacts of sanitation infrastructures through Life Cycle Assessment (LCA) is necessary for defining the best environmental management strategies. This study was conducted to assess the impact of barley production on environment under rain fed and watered farming systems in north of Iran. Data was collected using questionnaires and face-to-face interviews with 72 farmers in rural areas during the agricultural year 2011. In watered farming system, total green house gases emissions for barley production were calculated to be 497.7 $kgCO_2eqha^{-1}$. In rain fed farming system, total green house gases emissions for barley production were calculated to be 372.6 $kgCO_2eqha^{-1}$ calculated. Life cycle assessment (LCA) studies can help to develop this long term perspective, linking performance to minimizing the overall energy consumption, use of resources and emissions.

Keywords: Barley, Green house gases, watered farming, Rain fed farming.

INTRODUCTION

Barley (*Hordeum vulgare* L.) is one of the most important cereal crops of Iran and the world. The yield of Barley has increased twofold because energy consumption in Barley production has increased in recently years. The land area under barley production in Iran is about 1675654 ha which produces 3446228 ton of barley (Azarpour *et al.,* 2013). Iran is ranked the fifth country in the irrigated farming area, however, in the 20th rank, according to the total arable land. In addition, Iran also listed between 7th to 18th countries with the most GHG emission in world according to different reports. Soil erosion is a major environmental threat to the sustainability and productive capacity of agriculture by reduction of soil fertility and loss of nutrients and thus, declines of crop yields in farmlands. Mean annual soil erosion rate in Iran is about 25 tons/ha/year, 4.3 times more than the mean annual soil erosion rate in the world (Rostamian *et al.,* 2008). In a recent report by FAO, water scarcity and soil degradation are considered as major risks for Iranian agricultural production (FAO, 2011). Iran is situated in one of the most arid and semi arid regions of the world. The average annual precipitation is 252 mm (one-third of the world's average precipitation). Agriculture is responsible for 92% of yearly water withdrawal. Approximately 45% of water is supplied through surface water and 55% with groundwater. The average decrease in the groundwater table is 0.51 meter.

Water average efficiency in agriculture is estimated to be approximately 35 % (Emadodin *et al.,* 2012). Life cycle assessment (LCA) is a methodology for assessing all the environmental impacts associated with a product, process or activity, by identifying, quantifying and evaluating all the resources consumed, and all emissions and wastes released into the environment (Rebitzer *et al.,* 2004). During the last century, LCA was mainly used in industrial fields, but nowadays, most researchers have used it widely to assess the impacts of products, processes and activities on the environment as well as in agriculture. The system of agricultural productions in the world has been deeply changed because of using mechanization, chemical fertilizers and poisons and reformed seeds and as a result considerable changes in the direction of consumed energy in agricultural section have been created and caused higher relationship to the green house gases emission. Increased growth in agricultural production has resulted in increased agricultural greenhouse gas emissions. In 2010, global greenhouse gas emissions from the agricultural sector totaled 4.7 billion tons of carbon dioxide (CO_2) equivalent, up 13 percent over 1990. Agriculture is the third largest contributor to global emissions by sector, following the burning of fossil fuels for power and heat, and transportation. In 2010, emissions from electricity and heat production reached 12.5 billion tons, and emissions from transport totaled 6.7 billion tons.

Despite their continuing rise, emissions from agriculture are growing at a much slower rate than the sector as a whole, demonstrating the increasing carbon efficiency of agriculture.

From 1990 to 2010, the volume of agricultural production overall increased nearly 23 percent, according to data compiled by the United Nations Food and Agriculture Organization (FAO) for its program, FAOSTAT. FAO released a new Greenhouse Gas Emissions database for agriculture, forestry and other land use changes in December 2012, which can be found here. According to FAO, methane accounts for just under half of total agricultural emissions, nitrous oxide for 36 percent, and carbon dioxide for some 14 percent. The largest source of methane emissions is enteric fermentation, or the digestion of organic materials by livestock, predominantly beef cattle. This is also the largest source of agricultural emissions overall, contributing 37 percent of the total. The aim of this research is studying Optimization of greenhouse gas emissions for barley production under rain fed and watered farming systems in north of Iran.

MATERIALS AND METHODS

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. Data was collected using questionnaires and face-to-face interviews with 72 farmers in rural areas during the agricultural year 2011. 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)

Table 1. Amounts of inputs and their equivalent green house gas (GHG) emission for barley production.

Parameter	Unit	Quantity per Hectare (Rain fed farming)	Quantity per Hectare (Watered farming)	GHG coefficient ($kgCO_{2eq}ha^{-1}$)
Machinery	h/ha	12	12	0.071
Diesel fuel	L/ha	110	110	2.76
Nitrogen	Kg/ha	38	63	1.3
Phosphorus	Kg/ha	11	14	0.2
Potassium	Kg/ha	6	10	0.2
Poison	L/ha	3	3	5.1
Water	M^3/ha	0	1600	0.057

RESULTS AND DISCUSSION

The results of CO_2 emissions of barley production on environment under rain fed and watered farming in Table 5. In watered farming system results show that, about 1600 M3 water, 110 L diesel fuel, 12 h machinery power, 63 kg/ha nitrogen fertilizer, 14 kg/ha phosphorus fertilizer, 10 kg/ha potassium fertilizer and 3 L chemical poison were used in agro ecosystems barley production on a hectare basis. In rain fed farming system results show that, about 110L diesel fuel, 12 h machinery power, 38 kg/ha nitrogen fertilizer, 11 kg/ha phosphorus fertilizer, 6 kg/ha potassium fertilizer and 3L chemical poison were used in agro ecosystems barley production on a hectare basis. In watered farming system results show that, diesel fuel was the major source contributing 61% (303.6 $kgCO_2eqha^{-1}$) of total green house gases emission and followed by water, chemical fertilizer, poison and machinery contributing 18.32% (91.2 $kgCO_2eqha^{-1}$), 17.42% (86.70 $kgCO_2eqha^{-1}$), 3.07% (15.3 $kgCO_2eqha^{-1}$) and 0.17% (0.9 $kgCO_2eqha^{-1}$) of global warming potential, respectively (Fig. 1). Between chemical fertilizers, nitrogen had the first rank in green house gases emission and next ranks belonged to phosphorus and potassium with 16.46%, 0.56% and 0.40%, respectively (Fig. 1). In watered farming system, total green house gases emissions for barley production were showed Table 2 (497.7 $kgCO_2eqha^{-1}$). In rain fed farming system results show that, diesel fuel was the major source contributing 81.48% (303.6 $kgCO_2eqha^{-1}$) of total green house gases emission and followed by chemical fertilizer, poison and machinery contributing 14.17% (52.80 $kgCO_2eqha^{-1}$), 4.11% (15.3 $kgCO_2eqha^{-1}$) and 0.23% (0.9 $kgCO_2eqha^{-1}$) of global warming potential, respectively (Fig. 2). Between chemical fertilizers, nitrogen had the first rank in green house gases emission and next ranks belonged to phosphorus and potassium with 13.26%, 0.59% and 0.32%, respectively (Fig. 2). In rain fed farming system, total green house gases emissions for barley production were showed Table 2 (372.6 $kgCO_2eqha^{-1}$).

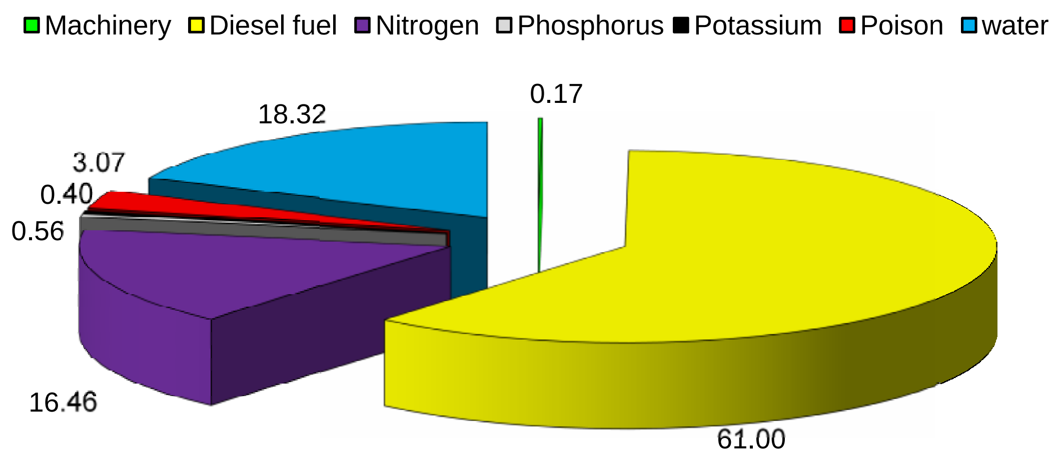

Fig. 1. The contribution of GHG emissions of barley production in watered farming system.

Table 2. Greenhouse gas emissions of inputs for barley production.

Parameter	GHG emissions ($kgCO_{2eq}ha^{-1}$) (Watered farming)	GHG emissions ($kgCO_{2eq}ha^{-1}$) (Rain fed farming)
Machinery	0.9	0.9
Diesel fuel	303.6	303.6
Nitrogen	81.9	49.4
Phosphorus	2.8	2.2
Potassium	2.0	1.2
Poison	15.3	15.3
Water	91.2	0
Total	497.7	372.6

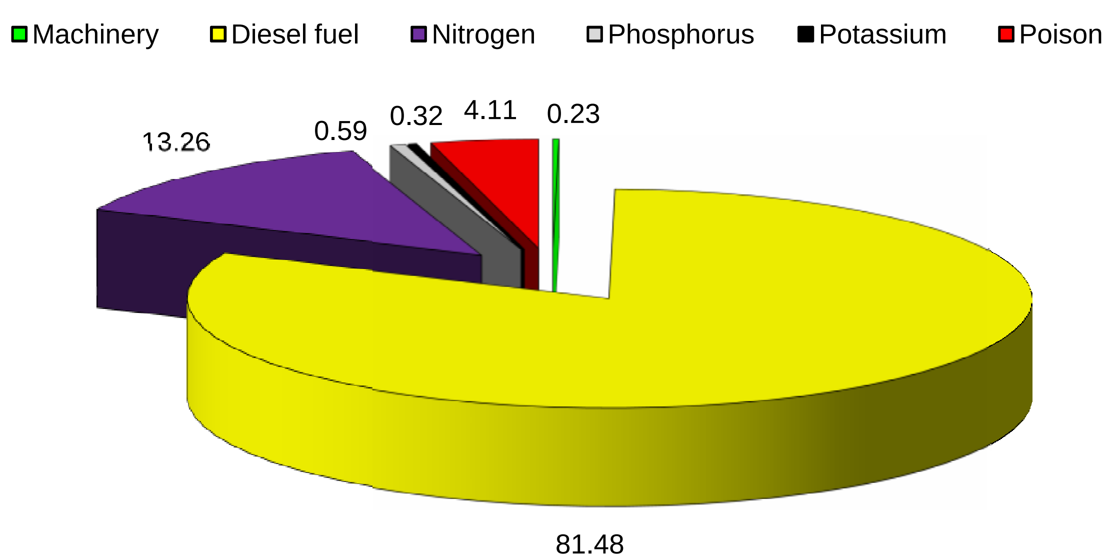

Fig. 2. The contribution of GHG emissions of barley production in rain fed farming system.

In another study, Ghahderijani *et al.*, (2013) investigated the energy consumption and CO_2 emissions for wheat production. Their results illustrated the total energy consumption and total CO_2 emissions was calculated about 31482 MJ ha^{-1} and 756 $kgCO_2eqha^{-1}$, respectively. Pathak and Wassmann (2007) reported a total emissions of 1038 $kgCO_2eqha^{-1}$ for wheat production. Khakbazan *et al.* (2009) calculated the CO_2 emissions from wheat production and found that it can be ranged from 410 $kgCO_2eqha^{-1}$ to 1130 $kgCO_2eqha^{-1}$ depending on fertilizer rate, location and seeding system. The total CO_2 emission of hazelnut production is very low compared to other agriculture products. Rajaniemi *et al.* (2011) calculated the CO_2 emissions from oats, barley, wheat and rye production were calculated to be 1800, 1930, 2330 and 2270 $kgCO_2eqha^{-1}$, respectively. Yantai *et al.* (2012) calculated the GHGs from barley were calculated to be 1003 $kgCO_2eqha^{-1}$. Production and delivery of fertilizer N to farm gate accounted for 26% of the total GHG emissions, followed by direct and indirect emissions of 28% due to the application of N fertilizers to barley crop. Emissions due to N fertilization were 26.6 times the emission from the use of phosphorous, 5.2 times the emission from pesticides, and 4.2 times the emission from various farming operations. Decomposition of crop residues contributed emissions of 173 $kgCO_2eqha^{-1}$, or 19% of the total emission. Indian Head-produced barley had significantly greater grain yield, resulting in about 11% lower carbon footprint than Swift Current-produced barley (0.28 vs. 0.32 kg COeq kg of grain). Emissions in the barley production was a linear function of the rate of fertilizer N applied to the previous oilseed crops due to increased emissions from crop residue decomposition coupled with higher residual soil mineral N. Conclusions: The key to lower the carbon footprint of barley is to increase grain yield, make a wise choice of crop types, reduce N inputs to crops grown in the previous and current growing seasons, and improved N use efficiency (Yantai *et al.*, 2012).

CONCLUSIONS

In this study, the inputs and output energy requirements for greenhouse barley production on environment under rain fed and watered farming systems were assessed in guilan and regions of Iran using a face to face questionnaire performed with farmers. In rain fed farming system, total green house gases emissions for barley production were calculated to be 372.6 $kgCO_2eqha^{-1}$ calculated. In watered farming system, total green house gases emissions for barley production were calculated to be 497.7 $kgCO_2eqha^{-1}$.

REFERENCES

Azarpour, E. (2014). Investigation life cycle assessment emission of varieties rice under traditional and semi-mechanized farming systems in Iran. *International Journal of Biosciences.* **4**(1): 8-14.

Azarpoue, E., Moraditochaee, M. & Bozorgi, H.R. (2013). Assessment energy, energy balance and economic indices of rain fed farming barley Production in North of Iran. *Journal of Biodiversity and Environmental Sciences.* **3**(11): 61-70.

Emadodin, I., Narita, D., & Bork, H.R. (2012). Soil degradation and agricultural sustainability: an overview from Iran. *Environment Development and Sustainability*. **14**: 611-625.

FAO. 2011. The state of the world's land and water resources for food and agriculture. Rome.

Ghahderijani, M., Pishgar Komleh, S.H. Keyhani, A. & Sefeedpari, P. (2013). Energy analysis and life cycle assessment of wheat production in Iran, *African Journal of Agricultura Research.* **8**(18): 1929-1939.

Khakbazan, M., Mohr, R.M. Derksen, D.A. Monreal, M.A. Grant, C.A. Zentner, R.P. Moulin, A.P. McLaren, D.L. Irvine, R.B. & Nagy, C.N. 2009. Effects of alternative management practices on the economics, energy and GHG emissions of a wheat-pea cropping system in the Canadian praprairies. *Soil & Tillage Research.* **104**: 30-38.

Khoshnevisan, B., Rafiee, S.H. Omid, M. & Mousazadeh, H. (2013). Regression modeling of field emissions in wheat production using a life cycle assessment (LCA) approach. *Electronic Journal of Energy & Environment.* **1**(2): 9-19.

Ozkan, B., Fert, C. & Karadeniz, C.F. 2007. Energy and cost analysis for greenhouse and open-field grape production. *Energy*. **32**: 1500-1504.

Pathak, H., Wassmann, R. (2007). Introducing greenhouse gas mitigation as a development objective in rice-based agriculture: I. Generation of technical coefficients. *Agricultural Systems*. **94**: 807-825.

Pishgar-Komleh, S.H., Ghahderijani, M. & Sefeedpari, P. (2012). Energy consumption and CO_2 emissions analysis of potato production based on different farm size levels in Iran. *Journal of Cleaner Production*. **33**: 183-191.

Rajaniemi, M., Mikkola, H. & Ahokas, J. 2011. Greenhouse gas emissions from oats, barley, wheat and rye production. *Agronomy Research Biosystem Engineering Special.* **1**: 189-195.

Rebitzer, G., Ekvall, T. & Frischknecht, R. (2004). Life cycle assessment part I: framework, goal and scope definition, inventory analysis, and applications. Environment International. 30: 701- 720.

Rostamian, R., Jaleh, A. Afyuni, M. Mousavi, S. Heidarpour, M. Jalalian, A. & Abbaspour, K.C. (2008). Application of a SWAT model for estimating runoff and sediment in two mountainous basins in central Iran. *Hydrology Science Journal*. (5): 977-988.

Yantai, G., Chang, L. William, M. Sukhdev, M. Junyi, N. & Xiaoyu, W. (2012). Carbon footprint of spring barley in relation to preceding oilseeds and N fertilization. *International Journal of Life Cycle Assessment*. **17**(5): 635-645.