

CARBON DIOXIDE EQUIVALENT EMISSION LOAD WITHIN PRODUCTION AND PROCESSING OF WHEAT UNDER CONDITIONS OF ORGANIC AND CONVENTIONAL FARMING SYSTEMS.

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Abstract

The achieved results proved, that the conventional wheat production release the CO₂e amount of 0, 5581 kg into the air compared to 0, 4624 kg of CO₂e produced by organic wheat. Higher amount of emission reached within conventional farming is primarily contributed to high volume of CO₂ emission released from easily dissolving conventional nitrogen fertilizers. An evident difference in emission load and greenhouse gases production is reached within flour production as well. It is 12% (0,5855 kg CO₂e) lower when the organic flour is produced compared to the conventionally produced flour (0,6664 kg CO₂e). Also transport plays an important role as far as the emission production is concerned. It has been proved, that regional transport (distance up to 50 km) contributes to the release of CO₂e by 0,0137 kg compared to super-regional transport (distance up to 400 km) producing the CO₂e amount of 0,1094 kg. Based on the achieved results it is evident, that the environmental load is affected by the farming system applied and observance of the principles of regional activity as well.

Key words: CO₂e, wheat, processing, organic farming

The climate change has still been a very current topic. A regular monitoring of emission and greenhouse gases is one of the required obligations by the United Nations Framework Convention on Climate Changes since 1992 and The Kyoto Protocol (Fott et. al., 2003). Due to the global warming up the climate zones may move by hundreds of kilometers northbound and would widely affect ecosystems in many regions of the world. Subsequently there might be affected the vegetations cycles, which would finally result in necessary changes in the crop structure and livestock production. According to Nemešová, Pretel (1998), the climate change includes both, the anthropogenic changes (resultant from human activities) and the natural changes as well. Then, the anthropogenic contribution to the climate change is an „addition“ to the natural global climate variability.

Since the beginning of the 19th century the concentration of carbon dioxide in the atmosphere has risen nearly by one half. If considered even locally, this means an important phenomenon, but globally this represents a very serious change. (Jůzlová et. al., 2004). Currently, as the most significant human intervention to the climate system are considered concentrations of greenhouse gases and anthropogenic tropospheric

aerosols, produced primarily within the burning process of fossil fuels and biomass (Kalvová, Moldon, 1996, Barros, 2006). In addition to the industry and the energy industry, agriculture is also considered a production process releasing significant amount of emission. In conditions of the Czech Republic methane and nitrogen monoxide represent the predominant emission gases. (Nátr, 2005). According to Nátr (2006), there is possible to make a deduction, that the amount and composition of our food reflect specific characteristics of particular technological production processes in agriculture and thus a different production of greenhouse gases. And this is why the principles of sustainable development in the industrialized countries may be significantly affected by the change in population nourishment resulting in necessary modification of the agricultural system.

The monitoring of particular emission loads under different agricultural systems can be based on the LCA analysis. According to Kočí (2009), this analysis uses for the evaluation of the environmental impact the assessment of the material and energy flows, that the monitored system shares with its surrounding space (the environment). The method of Life Cycle Assessment can also be characterized as a

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systematical practice, which based on the material and energy balances aims to define the extent and intensity of the complex negative impact on the environment, which cause the existence of an evaluated system (a product most often) within its life cycle. The term „Life Cycle“ means that the negative impact to the environment of a product is evaluated including the raw material characteristics and way of its production and further processing, through the product production process itself, consumption, to its final disposal. The evaluation also involves a negative impact caused by the transport (Remtová, 1996). The changes in production processes together with the stress put on the principle of regionality may be one of the instruments for greenhouse gases reduction and consequent reduction of the anthropogenic impact on the climate change.

MATERIAL AND METHOD

The CO₂e production was evaluated base on the monitoring of three production processes (agriculture, processing and transport). The calculation of CO₂ emission was carried out using the SIMA Pro software. This application is connected to the Ecoinvent database and is used for the simulation of given product life cycle according to the ISO 14044 standard. As the

secondary data were used the standards of agricultural production technologies, cultivation and processing technologies methodology, specialized literature, consultations with experts and system databases. The SIMA Pro software was used for the evaluation of wheat grain, wheat flour and wheat bread production. As a reference unit was given one kg of the product. For the calculation of agricultural inputs contributing to the release of direct and indirect N₂O emission was used the IPCC methodology (De Klein, 2006) combined with The Czech National Report to Greenhouse Gases Inventory, section Agriculture (Anonym 1, 2009). The emission of monitored greenhouse gases is related to its impact on the climate change and expressed in the equivalent CO₂-eqv ($CO_{2-eqv} = 1x CO_2 + 23x CH_4 + 298x N_2O$).

RESULTS AND DISCUSSIONS

According to (Anonym2, 2010), in the Czech Republic the share of greenhouse gases produced within agriculture made 6 % out of the total production in year 2008. This number defines the contribution of agriculture to the release of greenhouse gases and to what an extent we might be able to reduce the production of carbon monoxide, if more sustainable farming principles would be applied.

Table 1
Emission load of particular agronomical operations and inputs per 1 kg of wheat within the conventional and organic farming system

Agriculture	CO ₂ kg eq. per 1 kg of wheat	
	conventional farming system	organic farming system
fallow	0,0037	0,0057
fertilizers application	0,0047	0,0281
ploughing	0,0115	0,0176
heavy harrowing	0	0,0035
rolling	0,0023	0
sowing	0,0066	0,0100
pesticides application	0,0026	0
weddering	0	0,0040
harvest	0,0079	0,0121
transport from field	0,0016	0,0024
post-harvest processing	0,0003	0,0003
dung application	0	0,0511
N-fertilizers	0,2129	0
P- fertilizers	0,0227	0
K- fertilizers	0,0095	0
herbicides	0,0012	0
fungicides	0,0022	0
sowing material	0,0255	0,0391
N ₂ O emission	0,2431	0,2885
total	0,5581	0,4624

According to Fott et al. (2003) the most emission-productive operations are applications of manures and pesticides. This is very evident in Table. 1, where the wheat production within the conventional farming system shows 0,5581 CO₂-eqv / 1 kg of wheat and the organic farming system 0,4624 CO₂-eqv / 1 kg of wheat. This table also covers further differences between particular agronomical operations and inputs. The most intensive N₂O emission load results from manures and seed material. This shows the presumption presented by Daxbeck et al. (2008) that the emission load produced within conventional farming is higher compared to the organic farming system, that does not allow usage of the fast soluble fertilizers and pesticides. The emission from fertilizers and nitrogen monoxide within the conventional farming system represent 87 % and 74 % within the organic farming system.

Further emission load release comes into question within processing and transport of wheat. There are also evident differences between the conventional and organic farming system considering mentioned aspects. The results have proved production of organic flour and bread in an organic baker house requires higher energy

inputs compared to a conventional millhouse and baker house, which, of course, means higher emission production. For conventional flour this makes 0,0488 kg eq. CO₂ per 1 kg of product compared to 0,0794 kg eq. CO₂ per 1 kg of organic flour. For bread this makes 0,5933 kg eq. CO₂ per 1 kg of conventionally produced and 0,7333 kg eq. CO₂ per 1 kg of organically produced bread.

An important role plays also the transport, which can be divided into regional (distance 50 to 100 km) and extra regional (distance 200 to 400 km). The emission load per 100 km reaches 0,0274 kg eq. CO₂.

The emission released within the wheat production, transport and processing has to be completed with the emission released within the bread production itself and consequently by the emission of the final product transport (Table 2). When making a recalculation per one kg of bread, it is necessary to take into account that the amount of flour needed is 0,69 kg, which has to result in final reduction of produced emission of eq. CO₂ within flour production (0,4598 kg eq. CO₂ for the conventional and 0,4040 kg eq. CO₂ for the organic).

Table 2

CO₂ emission per one kg of produced and transported conventional and organic bread

Transport	conventional farming				organic farming			
	regional		extra regional		regional		extra regional	
distance (km)	50	100	200	400	50	100	200	400
CO ₂ emission per one kg of produced bread	1,0554	1,0554	1,0554	1,0554	1,1396	1,1396	1,1396	1,1396
transport	0,0137	0,0274	0,0547	0,1094	0,0137	0,0274	0,0547	0,1094
total	1,0691	1,0828	1,1101	1,1648	1,1533	1,1670	1,1943	1,2490

CONCLUSIONS

This study is a partial output of the Project EUS- M00080 – SUKI – The possibilities for dining facilities within reduction of the emission of carbon dioxide using the outputs of the VZ: MSM 6007665806 – The sustainable farming methods in submontane and mountain areas focused on the compliance between their production and non-production utilization.

Based on the achieved results, the amount of CO₂ emission for conventionally produced wheat reached 0, 5581 kg eq. CO₂ and 0, 4624 kg eq. CO₂ for organically produced wheat. The emission load released within the production of organic wheat is lower when compared to the conventionally produced wheat, which predominantly results from higher amounts of emission CO₂ due to the use of fast soluble nitrogen fertilizers. This corresponds to findings by LaSalle (2010), who states that

whole-area implementation of organic farming in the USA would lead to reduction of CO₂ emission by up to one quarter thanks to the increased carbon sequestration in soil. Within the flour production, there are the differences in production of greenhouse gases proved as well. For organic flour it is 12 % (0,5855 kg eq. CO₂) lower compared to the conventional flour production (0,6664 kg eq. CO₂). Also transport plays an important role. For example, regional transport (50 km distance) releases 0,0137 kg eq CO₂, extra regional transport (400 km distance) represents as much as 0,1094 kg eq. CO₂. The results have proved that the environmental load depends on both, the farming system applied and observance of the principle of regionality as well. It follows that the reduction of the emission load may be reached by both, application of suitable changes to the production methods towards the organic approach and

reducing transport with the preference of regional production.

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