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Impact Assessment of Mitigation Strategies in the Hungarian Agriculture

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ABSTRACT

In this paper we assess the domestic mitigation options to mitigate emissions from the agriculture with special regards to potential renewable utilization based on a UNFCCC assessment's results. We show that the condition of sustainable long-term production is the establishment and introduction of low-emission production processes.

1. Introduction

When assessing the relationship between climate change and Hungary's agriculture the impact of two major turn points should be underlined, the effect of transition (in the 1990's) which significantly restructured the corporate and production structure of our agricultural sector, and the EU accession which brought about new developments in the institutional framework (Common Agricultural Policy and its subsidy framework, the related cross compliance conditions, changes in domestic policies, etc.).

After Hungary joined the European Union (1 May 2004) the Hungarian agricultural sector was disadvantageously affected by the fact that the new Member States receive gradually the 100% of the direct Union payments, after a 10-year transition period, starting from 25%. National aid may be provided up to 30% as a compliment. As regards the system of single payments Hungary chose the SAPS (Single Area Payment Scheme) offered to the new Member States.

The financial problems and the debate over EU's common agricultural policy (CAP) induced an urging demand in the reform process launched in 1992 to develop a more target oriented subsidization framework which also promotes farming entities in responding to the environmental, social and economical challenges. Besides simplifying the direct subsidies and improving efficiency the Health Check of the CAP devotes a dedicated attention for the relation of environment and agriculture, primarily in water management, bioenergy production and biodiversity.

This paper focuses on agricultural production emissions and omits those of the land use, land use change and forestry (LULUCF) as the scope of analysis would surpass the boundaries permitted. However it has to be noted that many of the policies and measures analyzed herewith contain an indirect or direct impact on forestry, and certain emission elements are accounted for in the LULUCF sector.

2. Relevant factors and national circumstance in mitigation

Considering the average of the period 1985-2005 the emission from agriculture in CO2 equivalent is roughly 13% of the total emissions, which makes it the second largest emitter after energy use (Molnár S., 2007). In 2009, 12.5% of the GHG emissions expressed in CO2 equivalents of the Hungarian economy can be linked to the agricultural sector. This clearly highlights the fact that the GDP-proportional GHG emissions of agriculture are relatively higher than the respective figures of other sectors.

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As a result of the production decrease between 1990 and 1995, greenhouse gas emission from agriculture reduced significantly. In the period between 1996 and 2006, the level of production was essentially stagnant or slightly decreasing, particularly in animal husbandry. In a few of years (e.g. 2004, 2005), in some sectors of plant production (e.g. wheat and maize) the production increased due to the significantly high yield resulting from beneficial weather conditions.

The trend of overall emissions is summarized in Figure 1 (all emissions in CO_2 equivalents). Following the UNFCCC guidelines only CH_4 and N_2O emissions are considered here (key categories: CH4 Emissions from Enteric Fermentation in Domestic Livestock, CH4 Emissions from Manure Management, N2O Emissions from Manure Management, Direct N2O Emissions from Agricultural Soils, Indirect N2O Emissions from Nitrogen Used in Agriculture), CO_2 emissions are accounted for in the energy and the LULUCF sectors, respectively. The greenhouse gas emission of agricultural activities changed essentially according to the activity data: it slightly increased between 1995 and 2000 and stagnated between 2000 and 2006. The greenhouse gas emission from the agricultural sector in 2007 is 48.7% of the average of 1985-1987. It has to be emphasized here, that the projection basis for the Kyoto commitments of Hungary is the average of the years 1985-87. Figure 2 shows the trend of emissions by GHG sources compared to the base years 1985-87. The constant decrease in methane emissions in the period is the result of the constant reduction of the number of animals. Nitrous oxide emissions show similar trends until 1995, and there were a slight increase between 1996 and 2007. The main reason for it the increase in fertilizer uses. We note that, fertilizer use of the Hungarian agriculture sector is still only slightly higher than half of the amount between 1980 and 1985.

In the framework of our research, we developed a research portal that is meant to support research work applied in the meat industry, specifically pertaining to planned modern quality control and tracing systems and to the publication of the knowledge base connected with the topic (Figure 1).

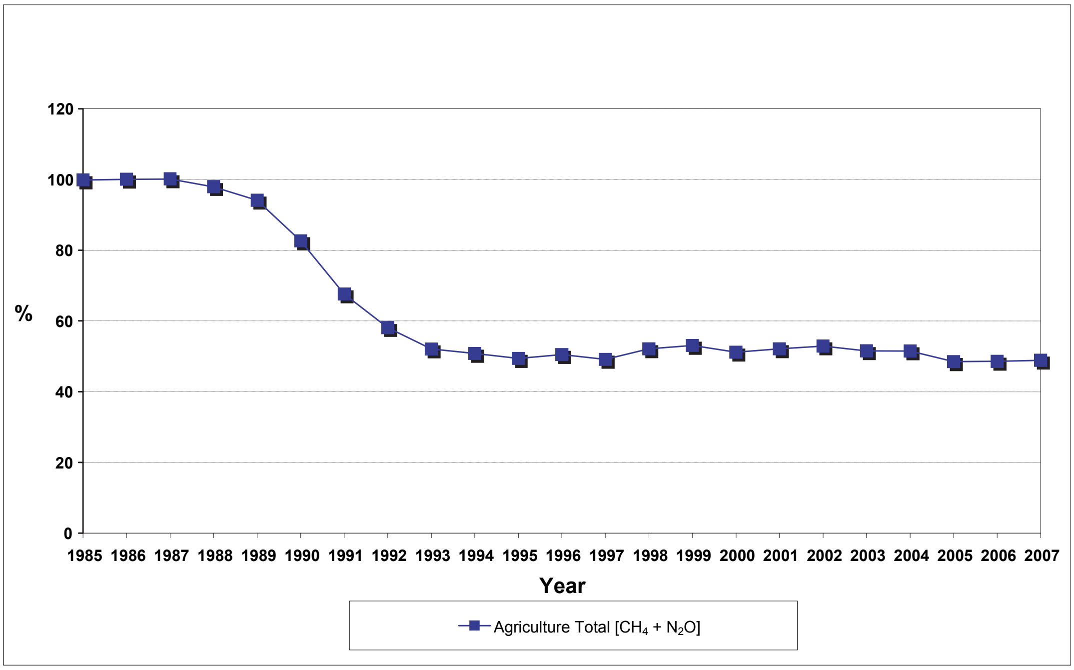

Figure 1. Past GHG emissions in CO2 eq. from Agriculture in % of base years

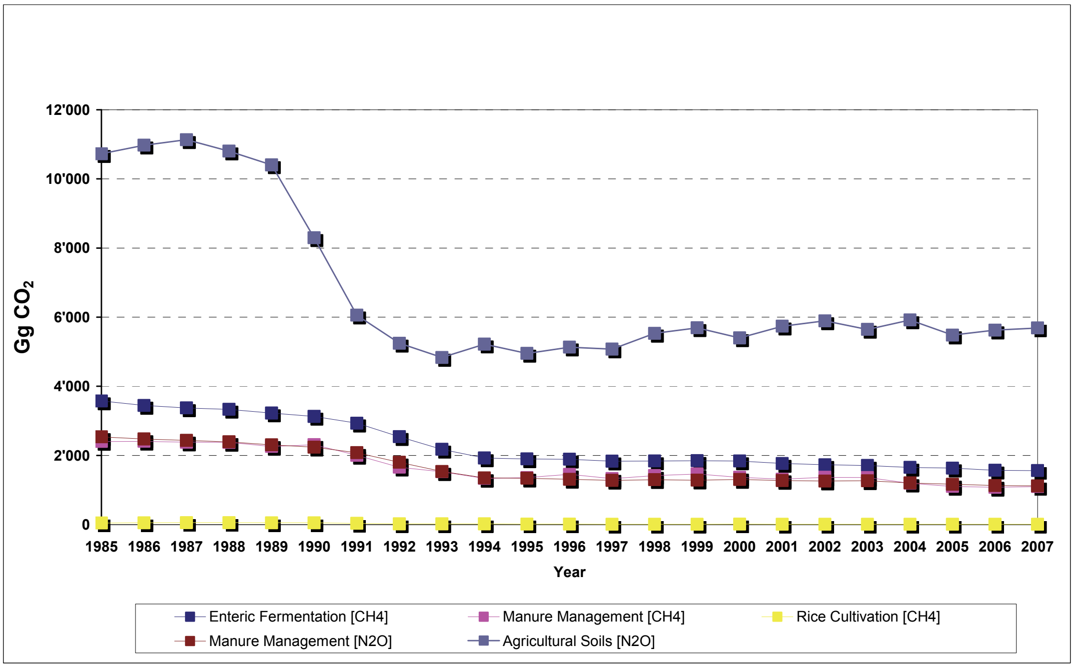

Figure 2. GHG emissions from Agriculture in CO2-equiv. by sources

3. Eligible policies and measures

As the member of the European Union, Hungary shares the responsibility of the fight against global climate change, so the Hungarian agriculture sector contributes to the global efforts in this field, although the most important field of reducing the anthropogenic greenhouse gas emissions is obviously not agriculture but the energy sector. Regarding the average greenhouse gas emissions of the period between 1985 and 2005 (in CO2-equivalents), agriculture takes 13% of the total; so it is the second largest emission sector after energy consumption in Hungary. The emission of agriculture decreases in absolute terms, and its share in total emissions also shows decreasing trend; in 1985 it was 15%, but in 2005 it was slightly over 11%. Looking at the entire greenhouse gas emissions, energy sector is responsible for emitting six times more than agriculture is. Even in the case of methane, the share of agriculture is only one-third. Still, the importance of agriculture is not negligible compared to the whole national anthropogenic greenhouse gas emissions. Though the emissions of agriculture origin were almost halved in the period of 1985-2005, this tendency mainly stems from the shrinking of production. The condition of the long-term sustainable production (increase of production) is to establish low-emission production processes (namely causing less atmospheric emission than the current ones) as well as the practical introduction and spreading thereof. (Molnár S. et al, 2001). The most important instrument of establishing agricultural production that is sustainable in terms of environmental-climate protection is the New Hungary Rural Development Program (NHRDP). In the course of preparing the New Hungary Rural Development Program (NHRDP) the results and experience of the previous period (PHARE, SAPARD, ARDOP [Agriculture and Rural Development Operational Program], NRDP [National Rural Development Plan]) were evaluated. The funds available under the PHARE, SAPARD, ARDOP and NRDP were used to start the restructuring and modernization of Hungarian agriculture and rural economy, but soon proved to be too modest to implement the much-needed changes.

New Hungary Rural Development Plan (NHRDP)

The programme is implemented under the framework determined by the European Union as well as by the domestic development policy documents.

The European Union framework is:

- Council regulation 1290/2005/EC
- Council regulation 1698/2005/EC

- Council regulation 144/2006/EC
- the Lisbon Strategy
- the sustainability principles determined in Gothenburg Technologies

The Hungarian development policy framework is the following:

- the National Development Policy Concept
- the National Regional Development Concept
- the National Action Plan
- the National Environmental Programme and the National Forest Programme

The Programme contains the strategic framework of the Hungarian rural development programme for the period of 2007-2013. The overarching national priority, in line with the Community Strategic Guidelines and the general objective is the following: "Improving outlets for arable production by modernising the livestock and processing sector and diversification into energy crops and horticulture." (FVM, 2008).

Concerning environmental load, the situation of the Hungarian agriculture is relatively favourable. The most severe agro-environmental problems in Hungary are caused by wind and water erosion, the loss of biodiversity, soil compaction and the abandonment of cultivation. (Abildtrup et al., 2006) The general improvement of environmental conditions and a more efficient protection of natural values are very important. The basic principle of sustainable farming is the application of a land use system, adapted to natural resources, the landscape, habitats, the characteristics and limitations of the environment, and the improvement of their quality. By so doing, biological diversity and the protection of prime natural values can be further strengthened. The intensity of protection will be defined in accordance with the natural values, the characteristics of the landscape and the preservation of the traditional rural landscape. This development direction contributes to the preservation of natural resources, including biodiversity, the maintenance of environmentally-friendly production procedures and of the renewable energy sources and to the dissemination of land use adapted to the character of the environment. All these indirectly contribute to the enforcement of the climate protection, GHG emission reduction aspects.

Four axes were elaborated in order to implement the programme. The main objectives and financial weights of the axes are the following:

- Axis I – Improving the competitiveness of the agricultural and forestry sector with the help of restructuring, development and innovation (financial weight: 47%)
- Axis II – Improving the rural environment through the support of the appropriate land use (financial weight: 32%)
- Axis III and IV – Improving the quality of life in rural areas and promoting the diversification of economic activities (financial weight: 17%)
- 4% of the sources is for technical assistance

In terms of climate protection several measures of the Axis I as well as many of the measures of the Axis II could be directly or indirectly relevant. These are as follows:

- Modernisation of husbandry sites
- Purchase of machinery and technological equipment
- Modernisation of crop production
- Support of production on less favoured areas
- Support of agro-environmental management
- Animal welfare payments
- First establishment of agro-forestry systems on agricultural lands
- Afforestation of agricultural lands
- Natura 2000

- Forest-environmental payments
- Restoring forestry potential and introducing preventive actions
- Support for non-productive investments

Based on the literature (Borka 2007, Fébel and Gundel 2007, Pazsiczky 2007), the technical possibilities of methane and nitrous oxide emissions reduction from agriculture can be summarized as follows.

Methane – in the field of feeding a smaller reduction (compared to the results achieved so far) can be achieved by increased feeding the cattle by fodder and fat but fodder ration is already high in Hungary, so further increase cannot be expected. The efficiency of the possible other measures (certain fodder additives, performance enhancers, defaunation, gene manipulation) in the field of feeding is controversial from several aspects, and their social acceptedness is also questionable. The rising production level reduces the specific (referring to one unit of a product, e.g. projected to one kg of milk) methane emission, but it could affect the absolute emission only in an indirect way, in connection with livestock. In the field of manure management methane emissions can be reduced by shifting from liquid manure to solid manure. In Hungary, however, the proportion of solid manure systems is already much higher than in Western Europe, so further significant shift is unlikely. There are target conflicts at the storage time and the selection of the management method of manure. Air and water protection interests (ammonia emission) are partially in contrasts with the interests of methane emission reduction. Further practice-oriented researches are necessary to elaborate concrete recommendations for managing manure in a low-methane-emission way.

Nitrous oxide – the reduction of nitrogen cycling proportionally reduces nitrous oxide emissions. The reduction of livestock or of nitrogenous fertilizers use also supports this. The reduction in the consumption of animal proteins also reduces the agricultural nitrogen cycle load, since the atmospheric nitrogen losses are significantly less in crop production than in animal breeding. It is a question how the consumer behavior develops in Hungary since, for example, in Hungary the per capita protein consumption in the 1990s fell behind the Western European level significantly. In the field of manure storage the use of liquid manure storage systems instead of solid manure storage systems results in significant emission reduction in the greenhouse gas inventory due to the lower emission factor of liquid manure storage. In this case, however, probably more direct and indirect nitrous oxide emissions are generated in connection with releasing liquid manure than in the case of solid manure. However, methane emission and the caused water protection problems are more severe in the liquid manure systems. With the division of the use of fertilizers into several stages the nitrate content of the soil, so the level of nitrous oxide emissions generated in the course of the denitrification can be kept low, especially if the individual fertilizer portions are formed in accordance with the actual demand of the plants. The use of slow-release fertilizers (releasing gradually the nitrogen content) could bring similar results. The use of the optimal fertilizer type in terms of weather conditions can reduce the nitrous oxide emissions of soils. Fertilizers with ammonium content usually bring higher emissions in dry soils, while fertilizers with nitrate content in cause higher emissions in wet soils. Emissions could be especially high if manure and fertilizers are released together. The reduction of excess nitrogen in feeding decreases the amount of nitrogen released through excrement, namely one of the most important sources of nitrous oxide emissions. Soil compaction increases nitrous oxide emissions, so any tillage measures reducing soil compaction decrease nitrous oxide emissions, too. In the field of meadow management the more frequent cutting of grasslands increases the mass of root biomass, so does the nitrogen absorption capacity of the vegetation, so reducing the nitrogen available for nitrification. The reduction of grazing period has positive effect on the nitrous oxide emissions, but this approach is in flat opposition to animal protection objectives. The nitrous oxide emissions generated during the release of manure are influenced by the release techniques, but the results are ambiguous. Therefore at the evaluation of release techniques the aspects of ammonia emission should be considered more important. The nitrification inhibitors prevent the transformation of ammonium into nitrate, so they remove the base material of nitrification, so they reduce nitrous oxide emissions, but they also have adverse side-effects.

The aforementioned examples also show that one could face severe conflicts of interests at different measures serving the reduction of nitrous oxide emissions. When evaluating the possible measures, beside the impact on nitrous oxide emissions other aspects should also be taken into account, for example: impacts on other greenhouse gas emissions, on ammonia emissions and on nitrate wash-out; animal protection aspects; conditions of practical production; reliability of the individual measures.

Estimations were performed for the summarized impact of the aforementioned measures on the GHG emissions. Measures were not estimated individually, the estimated impact of the entire measure group for the time period 2010-2025 was calculated and is presented in detail in Table 1 in the next section.

4. Projections for agriculture

The overall objective of the projections developed was to give a realistic picture of the mitigation potential in the respective sectors. Two major scenarios were developed to characterize the possible emission trends. The With Existing Measures Scenario was outlined to give the most probable outcome of domestic policies and measures existing or under implementation. The With Additional Measures Scenario was calculated to provide insight into a more optimistic future scenario, as such it can be considered as an optimal (thus unlikely) scenario.

The assumptions of WEM scenario were the application of adopted/implemented policies and measures as presented in the following subchapters, with some additions as follows.

- Renewable policy targets will be achieved according to the base case in the Governmental Renewable Strategy
- Existing policies and measures as described earlier will be implemented and are considered with the estimated savings potential.
- The effect of modernization, technological measures in the respective sectors will result in decreasing energy intensity, therefore energy savings arising later will result in a smaller emissions savings than those occurring at an earlier period.
- Since the framework for post-2013 EU ETS is not yet officially known, we assumed that from 2013 the same measures will be considered as a lower boundary for ETS sectors that are; we assumed the continuation of the emission cap at the present marker.

The assumptions of the WAM Scenario are as follows.

- Renewable energy utilization will be accordding to the higher scenario of the Renewable Strategy.
- Measures described earlier will be realised, other planned and possible measures will be implemented
- EU ETS will be prolonged until 2020, with non-ETS sectors taking a 10% reduction obligation (burden sharing). Without any numerical estimation existing at present point, the emissions allowances surrendered can just be forecasted, however the applied modelling framework allows for an assessment of emissions savings generated in the ETS sectors along unit price assumptions made.
- Mitigation measures are supported to the fullest possible extent.

For the period 2015-2020 the volume of agricultural production was forecasted using the assumption that production on the long run will approximate the level adequate to the ecological potential of the country due to the increasing food demand on the global market, to the expansion of export opportunities and to the measures of the NHRDP.

Regarding technical measures – among the possible primary measures – the reduction of the agricultural nitrogen cycle load (cut-back of excess nitrogen in feeding, rationalisation of fertilizer use) was considered. In the field of dairy production the intensification of production and the increase of milk yield were taken into account (Pazsiczky, 2007).

The emissions calculated for the period 2010-2025 were calculated according to the actual NIR (National Inventory Report for 1985-2007 Hungary, April 2009) methodology.

As realistic emission reduction measures the reduction of the N-excretion of livestock, the rationalisation of N-fertilizer use as well as the increase of the milk yield of dairy cattle were taken into account both in the framework of the Scenario “With Existing Measures” and of the Scenario “With Additional Measures”. Compared to the other scenario, the Scenario “With Additional Measures” uses a value of nitrogen release higher by 10-35%, of the use of nitrogen active agent lower by 5-10% and of the increase in milk yield higher by 10%. (Borka, 2007)

By 2025 the entire greenhouse gas emission of the Hungarian agriculture sector according to the Scenario “With Existing Measures” rises by 26% compared to the value of 2005, and by 7% according to the Scenario “With Additional Measures”. The reason for the increase is the expected increase of agricultural production. At the same time, the expected values of 2025 hardly reach 61% (Scenario “With Existing Measures”) and 52% (Scenario “With Additional Measures”) of the base year’s emissions (average of the years 1985-87). The results are summarised in Table 1.

Table 1. Total impact of policies and measures in agriculture

	Agriculture Total, in CO_2-Eq. [Gg/year]		CH_4 [Gg/year]		N_2O [Gg/year]	
	wEM	wAM	wEM	wAM	wEM	wAM
2010	10,047.14	9942.32	128.10	125.37	23.73	23.58
2015	10,937.66	10222.27	135.47	133.27	26.11	23.95
2020	11,415.75	10171.19	145.25	143.25	26.99	23.11
2025	11,819.35	10012.88	156.15	153.93	27.55	21.87

Source: own calculations, published 5th National Communication of Hungary, 2009

5. Conclusions

Similarly to the global trends, the emission from agriculture in Hungary compared to the sector’s contribution to the GDP is proportionally higher than that of other sectors. Emissions are highly sensitive to activity data, the economic transition and restructuring resulted in a drop of production and thus a reduction in emissions from the sector. Further research can be deemed necessary to identify possible sink capacities in the agriculture, as the mitigation potential is quite clearly identified and assessed.

The change of the share of crop production and animal husbandry in the agricultural production structure also significantly effects emissions. Institutional factors, policies (esp. the NHRDP) and measures have a significant mitigation potential, however a detailed cost-benefit analysis would be necessary to evaluate their economic benefit. The mitigation impact of (implementable) measures can be quite significant, however only additional measures will allow for a net reduction of the sector’s emissions.

Summarizing the results it seems that there are no simple and efficient technical methods to further reduce methane emissions from agriculture in Hungary at the moment. The Hungarian agriculture sector has already applied the possible measures. In the foreseeable future the methane emission of the Hungarian agriculture sector is mainly the function of the livestock number. An exception is dairy industry where the intensification of production, the increase of annual milk yield per one dairy cattle seems possible through the reduction of livestock number necessary to the production.

Similar conclusion can be drawn regarding the dinitrous-oxide emission of agriculture origin. Quantitative and qualitative development is expected both in animal breeding and crop production till

2025; at least until the past production level is reached that was in accordance with the ecological conditions of the country. The use of manure and N-fertilizers will be increasing rather than decreasing in the short run. Positive effects can be forecast regarding the realizable development in the field of protein feeding and the cut-back of excess proteins. This measure is executable, and its impact is unquestionable and significant. It could also be important that the efficiency of nitrogen use should improve in the agriculture sector, so this way the amount of nitrogen released into the environment as loss reduces. The impact of other, theoretically possible measures is difficult to evaluate due to the previously listed conflicts of interests and the complexity of modes of action.

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