HUNGARIAN AGRICULTURAL ENGINEERING
N° 29/2016 55-59
Published online: http://hae-journals.org/
HU ISSN 0864-7410 (Print) / HU ISSN 2415-9751(Online)
DOI: 10.17676/HAE.2016.29.55

PERIODICAL OF THE COMITTEE OF AGRICULTURAL AND BIOSYSTEM ENGINEERING OF
THE HUNGARIAN ACADEMY OF SCIENCES
and
SZENT ISTVÁN UNIVERSITY
Faculty of Mechanical Engineering

POSSIBLE CLIMATE FRIENDLY INNOVATION WAYS AND TECHNICAL SOLUTIONS IN THE AGRICULTURAL SECTOR FOR 2030

Author(s):
M. Borocz – L. Szoke – B. Horvath

Affiliation:
Faculty of Economics and Social Sciences, Climate Change Economic Research Centre, Szent István University,
1. Páter Károly Street, Gödöllő, 2100, Hungary

Email address:
borocz.maria@gtk.szie.hu, horvath@carbonmanagement.hu, linda890206@gmail.com

Abstract

Agriculture became the focus of the European Union's climate policy, and can be said to one of the most contradictory of the newly regulated sectors (constructed environment, transportation, waste management). This sector is responsible for the highest amount of emission regarding the two most dangerous greenhouse gases (N_2O, CH_4), which have a very high amount of carbon dioxide equivalent. The regulation topics of agriculture are an important question in the EU, and have been since a long time ago, from both an environmental, and an economical perspective. This is due to the post-WW2 Joint Agriculture Policy's main agricultural goals (foodstuff safety, and ensuring that safe food is acquirable) force decision makers to take a protectionist position, if this sector is involved. This is due to the fact that the actors of the sector reason how reining the budget in also makes it harder for them to complete the goals, in case any action is planned. Technically, even the sector's division into sub-sectors isn't final, since no definite action was taken to either include or exclude the LULUCF (Land Use, Land Use Change and Forestry) sector. The goal of our research is to define low-carbon (material- and cost-effective) development paths using the assumed future trends of the Hungarian agriculture, which may aid the sector in achieving the climate policy goals it was given.

Keywords

low-carbon agriculture, climate policy, GHG reduction, renewable energy, energy efficiency

1. Introduction

The climate policy of the European Union shows agriculture as an individual sector to be one of the most contradictory sectors [1]. The first hardship is the actors themselves, who have to be regulated somehow, as they appear as a harder-to-count target audience than the industrial units which were regulated before. This is due to the dominant presence of the private sector, which makes it harder to divide emission resources. Even though this problem plagues many other sectors as well, which were included in the EU climate policy's interests after 2012, similarly to agriculture, taking regulatory actions is the hardest for agriculture [2]. Agriculture became an important part of the global European thinking's interests, when the foodstuff safety, and securing safe food became one of the most fundamental factors of the Joint Agricultural Policy, which grew to one of the main political priorities of the continent. Ever since then, economy professionals knew that the competitiveness of the sector is having problems due to the artificial regulations of today, which originates from the protectionist handling around it [3]. This behaviour makes it hard to advocate regulations from a climate policy perspective. Since any regulatory actions result in the sector's stakeholders arguing how they would be constricted in aiming to fulfil the objectives mentioned before [4].

Another important element is the uncertainty around the LULUCF (Land Use, Land Use Change and Forestry) sector, which further complicates the already complicated topic. It's important to note about the LULUCF sector that it has a significant GHG (greenhouse gas) capturing share [5], which lowers the CO2 balance of various countries. However, it's not under the jurisdiction of agriculture's regulation policy. This mainly appears as a disadvantage for countries like Ireland, where most of the emission results from this sector [6]. Nowadays, these countries have the main objective of reasoning for the inclusion of LULUCF, but decision makers still refuse to accept it. The reason for this is that introducing the system might cause countries with a high agricultural GHG emission to invest in cheap forestation projects instead of development projects which would yield more in-depth innovation and significant emission rate decreases [7, 8]. If we take a look at how Hungary fares, the situation is not as complicated as for global European processes. Many professionals think that our country is at the front in the race for completing GHG reduction goals, and the most significant threat is the unused potentials causing deadweight [9]. After all, agriculture is not only an energy consumer, but an energy producer as well [10], which may not only cause it to be self-sufficient, but also serve as a supplier for other sectors [11]. Though Hungary has a bio-ethanol production significant even in the EU, most of it is exported, and other methods of energy production (f.e. biogas) are still not taken advantage of [12]. The above mentioned facts therefore makes the goal of our research to evaluate possibilities of climate friendly development for the next program timeframe in the European Union after 2020, and to determine technology-development paths which we find to be the best.

2. Material and methods

Due to climate policy goals, and the many faces of the sector we analysed, we chose to base our evaluation on the benchmarking method. Benchmarking in essence is a level-comparison method, which uses a specifically created indicator system that makes it possible for us to compare a sector's state both in space and time [13]. We primarily employ a mechanism which also evaluates future developments based on the condition system tailored for the present state of affairs. The reason for choosing this methodology is that benchmarking is an analysis which can be shaped at will, and tailored specifically to analysis goals [14, 15]. Our analysis concluded this according to the cornerstones of the European Union's climate policy, taking the development processes of Hungary's agriculture which are currently underway into consideration. Our analysis aspects were the following:

– shares of renewable energy resources in the sector,
– level of energy-efficiency, and opportunities to raise it,
– aspects of decreasing CO_2 or GHG emission rates.

It's widely known that the EU values are defined according to the criteria listed for both 2020 and 2030, therefore, we mainly concentrated on how successfully will Hungary be able to achieve these values. Finally, as this analysis evaluates the opportunities of agricultural low-carbon developments, we were careful in making sure that all indicators define the technological side of the analysis aspects. This can be seen in Tables 1, 2 and 3.

Table 1. Indicator group 1 of the agriculture sector's benchmarking analysis
Abbreviations: "RS1, 2, 3" - state indicators of renewable energy's shares by dimension; "RP1, 2, 3" - performance indicators of renewable energy's shares by dimension

Code	**State indicators**	**Code**	**Performance indicators (and how they were formed)**
ASPECTS OF RENEWABLE ENERGY SHARE			
RS1	Specific analysis and general attributes of used energy mix	RP1	Change in usage of non-renewable energy sources, increase or decrease of fossilised energy sources used in the sector between 2020 and 2030
RS2	Standard of attributes for producing renewable energy	RP2	Development of energy plant's evolution
RS3	Level and attributes of using renewable energy sources	RP3	Possibilities of using renewable energy sources in the sector

Table 2. Indicator group 2 of the agriculture sector's benchmarking analysis
Abbreviations: "ES1, 2, 3" - state indicators of the energy efficiency aspect by dimension; "EP1, 2, 3" - performance indicators of the energy efficiency aspect by dimension

Code	**State indicators**	**Code**	**Performance indicators (and how they were formed)**
ASPECTS OF INCREASING ENERGY EFFICIENCY			
ES1	Share of electric energy usage compared to other sectors	EP1	Share of electric energy usage of the total energy needed
ES2	Amount of consumption limited by ETS sectors	EP2	Usage of electric energy
ES3	Opportunity and level/amount of cleantech implementation	EP3	Growth potential of energy from manure

Table 3. Indicator group 3 of the agriculture sector's benchmarking analysis
Abbreviations: "CS1, 2, 3" - state indicators of the CO2 decrease aspect by dimension; "CP1, 2, 3" - performance indicators of the CO2 decrease aspect by dimension

Code	**State indicators**	**Code**	**Performance indicators (and how they were formed)**
ASPECTS OF DECREASING CO_2 EMISSION LEVELS			
CS1	Intensity of GHG emission by technology	CP1	GHG emission levels by evaluation of available technological solutions
CS2	Possibility of introducing low-carbon technologies in the sector	CP2	Share of bio-ethanol in the usage of bio-fuels
CS3	Composition and volume index of typical GHGs	CP3	Decrease potential of CO_2 share in all GHG emission

As Table 1 clearly shows, our indicators were further sorted to two aspects, state and performance indicator groups. The former signifies a starting point, the knowledge of which is required for an overall analysis of the agriculture. The latter is an indicator based on the former, which makes it possible to measure the static state indicator element, which can be used to determine the way and amount of changes in the system. However, for forecasts in 2030, we had to create an analysis basis, which could be used to relate the assumed state. This is what we designated the year 2020 for, which is the program timeframe's end date for the current European Union program. Therefore, the indicators above were defined for 2020 using the currently known basis of 2010 via a calculation, and after defining the 2010-2020 interval, we were capable of evaluating the 2020-2030 interval.

Evaluating the indicators listed was required to determine the external effects (non-marketed influencing factors) in the sector.

Climate policy interpretation of externalities

During our analysis, external effects aren't interpreted as classic economy does in literature sources [16, 17], but instead are used to evaluate all positive or negative factors, which may have an effect on the future changes, engineering development of agriculture, but are excluded from decisions [18]. As for analyses which are used to evaluate the appearance of externalities, those are used to localise market errors, the contradictions of development paths, and other factors which may aid or impair the development of the system. During the evaluation of various indicators, we followed a simple principle - how the given element influences the sector in its goal to reach climate policy results. This is how all 3-3 indicators of each group were assigned a value of (-2), (-1), (0), (1), or (2), where negative numbers represent under-performance, while positive numbers represent over-performance. 0 is the optimal operation of the system (best practice), and any difference compared to this value means externalities are amassed by the system. In case this shows a positive change, the system doesn't operate at maximum efficiency, since it holds potential not taken advantage of. And in case there are overall negative externalities present, we can say the system's framework is fundamentally wrong, which has to be changed before any kind of development actions are taken [19, 20].

3. Results

Based on what we've written in the methodological introduction, we summarised our research results in Table 4. We followed 3 guidelines when summarising externalities. Guideline "A" (amount of net positive externalities) required us to mathematically summarise positive and negative externalities, which is how we were able to get the net positive values. Guideline "B" was interesting due to the total amount of externalities (positive and negative alike) present in the system, which is why their absolute values were summarised. The most important guideline was "C", where we checked how much the share of net positive externalities (A) is in total externalities (B). Therefore, if the former already produces a negative value, "C" also became 0%.

Table 4. Evaluation of the agriculture sector's benchmark analysis
Explanation - A: Net positive externality ∑ (1;3): the amount of positive externalities within various aspects in 2020 nd 2030, if there are no concrete climate policy developments outside of BAU; B: total externality ABS ∑ (1;3): the amount of all externalities in absolute value; C: the share of net positive external effects in the total external effect in percentage, which shows the dimension of possibility for developing for the analysis' focus sector.

Number	ASPECTS OF RENEWABLE ENERGY SHARE		ASPECTS OF INCREASING ENERGY EFFICIENCY		ASPECTS OF DECREASING CO_2 EMISSION LEVELS	
	2010/2020	2020/2030	2010/2020	2020/2030	2010/2020	2020/2030
1	-1	0	-1	0	-1	-1
2	2	1	-1	0	1	2
3	1	2	1	2	2	2
A: Net positive externality ∑ (1;3)	**2**	**3**	**-1**	**2**	**2**	**3**
B: Total externality ABS (1;3)	**4**	**3**	**3**	**2**	**4**	**5**
C: Net positive externality's share in total externality	**50%**	**100%**	**0%**	**100%**	**50%**	**66%**

Now, let us see how the structure of externality amassment changed between analysed intervals. Illustration 1 already shows the final state in 2030, where the mass of positive externalities shows unused potentials. This isn't a shock, seeing how decision makers tend to do their business, as it's been widely known for a while that agriculture has enough energy production possibilities not only for itself, but for other sectors as well [21]. However, we should also use Table 4 to understand what processes concluded in the sector to reach this state. We can see that the aspects of renewable energy share and CO_2 emission decrease have positive externality masses already, meaning the system doesn't operate efficiently even now. Therefore, it's no surprise that not properly making use of low-carbon technological solutions causes the wrong framework of raising energy efficiency, which makes this the only negative externality amassing aspect until 2020, according to the analysis. The changes seen in the technological dimension of the sector therefore point to the need for spreading low GHG emission technological solutions to realise an optimal agricultural sector from a climate policy perspective, not only in the long-, but also the short-term.

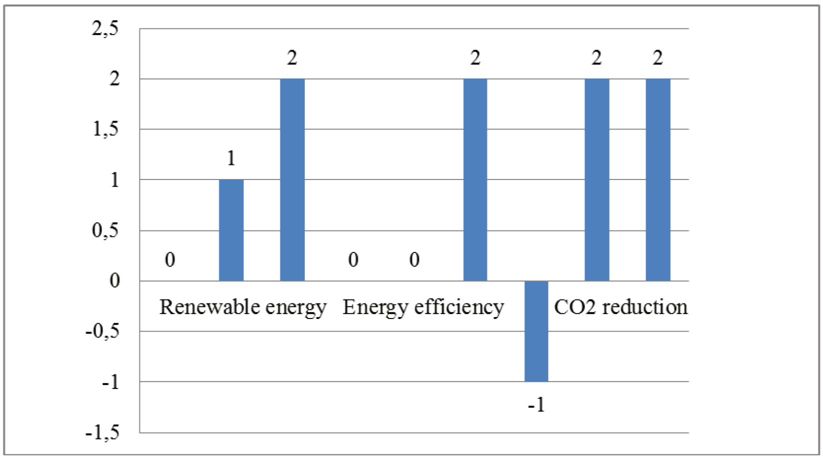

Figure 1. The number of externalities in 2030 regarding technological development

4. Conclusion

The goal of our analyses was to understand what level of influence technological development solutions have, or may have in the agriculture sector's, as a sector under climate policy regulation, endeavours in reaching long-term goals. Basically, we began from the hypothesis that the agriculture is a sector with an energy production potential that can support not only itself, but other related sectors with environment-friendly green energy. The analysis' results showed that our previous statement held true, since not properly used opportunities represented by positive externalities were concentrated within the agricultural system. This operation, not even close to efficiency leads to the fact that apart from energy efficiency, GHG emission decrease, which is the main goal of climate policy doesn't get enough of a role either. This fact may pose a serious problem long-term (until 2030, or 2050) not only for our country, but for the EU as well, for two reasons. One would be that it doesn't help with balancing the performance of sectors where basically negative operations can be seen, and even then, we need a high amount of costs to reach an advantageous GHG emission value. Another would be that currently unused potentials always cause an emergency, since if their investments are neglected today, we can't know what price tag they will have tomorrow. The reasons we listed, and the research results show that it's highly advised to begin the low-carbon, intensive development of the sector, as quickly as possible. The main goal of the climate-friendly developments may be the realisation of the energy self-sufficient program of the agricultural system based on energy-efficient agricultural methods, since it has a relatively low GHG emission prevention cost, 60-80% less compared to other sectors. The climate friendly development of agriculture may continue with agriculture entering the energy supply market after leaving the self-sufficient level, but this requires the energy resource produced to be competitive in trade. This may only become a proper alternative with extremely high (100-130 USD for a Brent of oil) fossilised energy resource prices, and stable consumption trends, according to currently available information.

References

[1.] Forster D., Okamura S., Wilkins G., Morris M., Scott P., Kuikman P., Lesschen J. P. Gardiner A., Boermans T., Grözinger J., Eichhammer W., Reichardt K.: 2012. Next phase of the European Climate Change Programme: Analysis of Member States actions to implement the Effort Sharing Decision and options for further community-wide measures. AEA group, Harwell, United Kingdom.

[2.] Borkent B., O'Keeffe S., Neelis M., Gilbert A.: 2012. Costs and Effectiveness of Domestic Offset Schemes, Final report. Ecofys, London, United Kingdom.

[3.] Matthews A.: 2012. Greening the CAP: the way forward, QA Rivistadell'Associazione Rossi-Doria, 4, 37-60. http://dx.doi.org/10.3280/QU2012-004002

[4.] Leduc G., Blomen E.: 2009. Sectoral Emission Reduction Potentials and Economic Costs for Climate Change (SERPEC-CC), Transport – Passenger cars, road freight and aviation. Ecofys, London, United Kingdom.

[5.] Fogarassy Cs., Neubauer E.: 2016. Evaluation of the regional water usage in Hungary with water allowance coefficient (WAC). Applied Ecology and Environmental Research 14:(1) pp. 161-173. http://dx.doi.org/10.15666/aeer/1401_161173

[6.] Barry F., King M., Matthews A.: 2010. Policy Coherence for Development: Five Challenges, Irish Studies in International Affairs, 21, 207-223.

[7.] Loum A., Fogarassy Cs.: 2015. The effects of climate change on cereals yield of production and food security in Gambia. Applied Studies in Agribusiness and Commerce – APSTRACT Vol. 9. No. 4. pp. 83-92. http://dx.doi.org/10.19041/APSTRACT/2015/4/11

[8.] Torok T., Szabo Z. L., Zsarnoczai J. S.: 2015. Methane reductions to moderate the global warming effects. Applied Studies in Agribusiness and Commerce APSTRACT Vol. 9. Number 4. pp. 59-64. http://dx.doi.org/10.19041/APSTRACT/2015/4/8

[9.] Fonseca M. B., Burrell A., Gay H., Henseler M., Kavallari A., M'Barek R., Domínguez I. P., Tonini A.: 2010. Impacts of the EU biofuel target on agricultural markets and land use: a comparative modelling assessment. European Commission, Joint Research Centre, Seville, Spain.

[10.] Magda R.: 2011. A megújuló energiaforrások szerepe és hatásai a hazai agrárgazdaságban. Gazdálkodás – Agrárökonómiai Tudományos Folyóirat, 2011. 06. szám, Budapest, Magyarország.

[11.] Elbersen B., Startisky I., Hengeveld G., Schelhaas M. J., Naeff H., Böttcher H.: 2012. Atlas of EU biomass potentials. BiomassFutures Project, London, England.

[12.] Fogarassy Cs., Horvath B., Szoke L., Kovacs A.: 2015. Low-carbon innovation policy with the use of biorenewables in the transport sector until 2030. Applied Studies in Agribusiness and Commerce – APSTRACT. Vol. 9. Number 4. pp. 45-52. http://dx.doi.org/10.19041/APSTRACT/2015/4/6

[13.] Fogarassy Cs., Nabradi A.: 2015. Proposals for low-carbon agriculture production strategies between 2020 and 2030 in Hungary. Applied Studies in Agribusiness and Commerce – APSTRACT Vol. 9. No. 4. pp. 5-16. http://dx.doi.org/10.19041/APSTRACT/2015/4/1

[14.] Camp R. C.: 1992. Learning from the Best Leads to Superior Performance. Journal of Business Strategy, Vol. 13 Iss: 3, pp. 3-6. http://dx.doi.org/10.1108/eb039486

[15.] Bakosne B. M., Fogarassy Cs.: 2011. A hazai húsmarha-tartás környezeti értékelése és externáliáinak vizsgálata benchmarking módszerrel. Gazdálkodás, 55 (2). p. 181. ISSN 0046-5518

[16.] Pigou A. C.: 1920. The Economics of Welfare, MacMillan, Part II., London pp. 33-34.

[17.] Fogarassy Cs.: 2014. The Interpretation of Sustainability Criteria using Game Theory Models (Sustainable project development with Rubik's Cube), Budapest; Paris: L' Harmattan Publisher, p. 140

[18.] Al-Boainin M. R., Szelényi L., Zsarnoczai J. S.: 2013. The gas emission in environmental pollutions and as externalities in point of view of economy. Economics of Sustainable Agriculture. pp. 159-171. ISBN: HU ISSN 2062-445X

[19.] Fogarassy Cs.: 2012. Karbongazdaság (low-carboneconomy). Monográfia. L'Harmattan Kiadó, Budapest, 2012, ISBN: 978-963-236-541-1 p. 262.

[20.] Fogarassy Cs., Horvath B.: 2015. Low-carbon building innovation trends and policy perspectives in Hungary between 2020 and 2030 YBL Journal Of Built Environment 3:(2) pp. 17-23.

[21.] Fogarassy Cs., Horvath B., Kovacs A.: 2015. Cross-sector analysis of the Hungarian sectors covered by the Effort Sharing Decision – Climate policy perspectives for the Hungarian agriculture within the 2021-2030 EU programming period. Applied Studies in Agribusiness and Commerce – APSTRACT Vol. 9. No. 4. pp. 17-24. http://dx.doi.org/10.19041/APSTRACT/2015/4/2