Effects of Agricultural Structure Changes on Profit Development in the Field (Exemplified by the Czech Republic)

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Abstract: - The paper analyses some aspects of the promotion of the use of biofuels, primarily fuel additives. Some conclusions are drawn from the data for the Czech Republic – it is stated primarily that the increasing share of biofuels in fuels has its explicit limits that are not given so much by technological problems as by the capacity for the cultivation of the crops that are used to produce biofuels. The paper concludes, for instance, that any plan to increase the share of renewable sources in diesel fuel above five to sever percent is essentially unfeasible, as it would either require significant imports of materials (rape seeds) or additives (usually rape seed methyl ester), or significant expansion of the land used to grow rapeseed. However, in terms of sustainable management of agricultural land, the areas suitable for rapeseed cultivation are quite limited in the Czech Republic and reached their full capacity viable in terms of considerate agricultural activity in 2011.

Keywords: - Biofuels, bioethanol, biodiesel, energy industry, methyl esters, agriculture, European Union, rapeseed.

1 Hypotheses

We witnessed multiple diverse phenomena relating to the development of agricultural production focused on the cultivation of plants that serve the follow-up production of "biofuels" from 2008 to 2011, including, for instance, a dramatic rise of food prices in 2008, or many studies that doubted and have continued to doubt the use of additives of biological origin in standard fossil fuels. This has motivated some amendments of EU legislation.

In this text, we will focus on the analysis of sustainability of projects aiming to increase the share of biofuels in the total consumption of fuels in the European Union, as prescribed in the original regulations and as achievable after their amendments.

For this purpose, we will formulate two hypotheses:

- Plans to increase the share of biofuels in the total consumption of fuels have their limits. Not technical, technological or economic limits, but primarily limits given by the achievable capacity of biofuels production.
- Although further biofuels development along the lines of the plans and binding rules applicable to Members States in EU legislation is problematic in terms of these projects' effects on long-term sustainability of European agriculture from the perspective of compliance with agrotechnical standards, they have a strongly positive impact on the farmers as the cultivation of energy plans increases the stability of the entire sector and has high financial effects.

Biofuel is usually, and with a high degree of simplification, understood as unsaturated fat acid methyl ester of vegetable origin, usually acquired from rapeseed. This fuels is usually designated at FAME - Fatty Acid Methyl Ester).

Secondly, the general term of biofuels often includes bioethanol, which is really alcohol produced to be mixed with petrol. This alcohol is

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often made of grain and from sugar beet or other plants rich directly in sugar or at least starch.

2 The Rise of Energy Crops

In about the last two decades, we have witnessed significant global changes in agricultural production. These changes primarily signal the decline of food production (animal and vegetal), hand in hand with pronounced interlinking of the agrarian and energy sectors. In simple terms, the changes predominantly entail a sharp change in vegetable production and a rise of cultivation of plants that can serve either as the starting material for the manufacture of fuels or additives in fuels, or as the basis for fuel suitable for combustion in heat or electricity generation. This change occurs regardless of the fact that the demand for food witnesses an inevitable rise on the global scale, a logical consequence of an ever-increasing number of the world's population.

(The truth be said, population growth in rich countries with generally the highest consumption can be deemed marginal: the demographic curve in many of these states has actually peaked, signalling a population decrease. Population growth is most pronounced in countries that can be defined as the poorest in the world and where food consumption per capita is the lowest. However, this cannot conceal the fact that global population has been growing continuously and will continue to grow in the decades to come.)

However, demand for technology crops that can be used for energy production has caused severe environmental damage in many parts of the world. Brazil, among others, is often mentioned in this respect: the combination of demand for timber with the need to obtain new arable land suitable for sugar beet cultivation (in additional to sugar production, sugar beet is also used as the starting material for ethanol production) has lead to uncontrolled loss of rainforests in Amazonia.

It is much less known that the suspected loss of the green mass on the planet, including, but not limited to, the loss of tropical forests, has been challenged on the global level several times. In this context, much insight has been given by *Difficulties in tracking the long-term global trend in tropical forest area*, a study by Alan Grainger [1] who, among other things, proved by detailed examination of satellite images that contrary to popular belief, rainforest areas in general hardly witness any quantitative changes. Nevertheless, the tropical forests move and relocate; Grainger himself notes that his study fails to capture the insurmountable regional environmental damage, and thus cannot be used to assert that tropical forests face no threats. is Brazil especially is the home of numerous specific and precisely documented cases and long-term processes proving that the tropical forest is regressing, with agricultural production taking its place. However, this production does not focus on food but much more often on products used to manufacture ethanol. Why is the deforestation pressure so strong in Brazil? The explanation is quite easy: the country has set out very strict rules for adding ethanol in petrol – the fuel must contain at least 25 percent of additives made from crops (compared to 5 percent in the EU, 5.9 percent in the USA, and ten percent in Australia).

However, Brazil is hardly alone in facing a threat to its tropical forests. We see very similar effects in many other parts of the world, for instance in the Pacific, and the same starts to happen in Africa. With the exception of Brazil that has launched an extensive government programme promoting the production of ethanol as fuel for personal vehicles, these changes have been "exported" from developed countries to less developed countries with a strong agricultural production. The demand of the rich countries for bioenergy products is supported by strong subsidies from their public budgets.

Due to this demand, farmers in many parts of the world must decide whether it is convenient for them to stick to traditional production or whether there is money to be made when they change their crops. Without journalists or scientific circles paying much attention, the very generous support to biofuels in effect and undoubtedly promotes energy-focused agriculture at the expense of traditional productions in the EU member states and elsewhere.

This problem is mostly observed from an environmental perspective, and there have been serious attempts to find out to what extent does the environment truly benefit from the cultivation and subsequent use of these technology crops. Without any ambition to resolve this issue in this paper, we can state that the voices of sceptics seem to start enjoying prevalence. They say that the new agricultural trend that focuses on very extensive cultivation of technology crops causes more harm than good. We will give some brief attention to these voices in the paragraphs that follow.

However, energy-focused agriculture is seldom approached as an economic problem in the entire scheme of things. We may find many unusually interesting research fields in this context.

The truth is that although traditional raw materials for energy production (oil, gas, coal, uranium and other elements suitable for the

production of nuclear fuels) witnessed a dramatic price hike in the past decade, their use is still substantially cheaper than that of the products of energy crops cultivation. Later in this paper, we will come to the conclusion that this is bound, on principle, to remain the truth at any time, regardless of what the price of traditional fuels may be. This relation could change only with a combination of very extreme circumstances.

However, this means that energy crops cultivation can be operated at any time in the future solely as a result of a system of state aid that forces the consumer to use biofuels, or as a result of massive promotion or direct price subsidies. Regardless of the form of support granted, the existence of energy crops cultivation will always be the result of a political decision.

3 Some Impacts of Agricultural Changes

The changes in the structure of agricultural production follow changes in the demand and the purchasing power of this demand. If there is demand for vegetable substitutes of fossil fuels, this demand will push away demand for foods for several reasons at once, including two principal reasons.

First, the use of biofuels finds support from governments in the developed countries, and thus relatively large and identifiable amounts of money can be found in the production and processing of these fuel additives or biomass production. No direct subsidies are paid towards fuels based on vegetable products in the Czech Republic; nevertheless, an essentially direct support is paid towards biomass production – albeit through the guaranteed purchase price of electric power generated from this source. In addition, we should not forget the fact that many investments in the energy industry and ultimately in the production of motor fuels have access to various forms of financial support from public sources.

Second, government intervention in the biofuels production system to some degree eliminates effects that may include dramatic shifts (primarily declines) in demand, common in other fields. Entrepreneurial safety of all the parties of the biofuels production chain or the biomass production, processing and combustion process is crucially increased by the simple fact that legislation in place safeguards these products' use. For instance, the inclusion of additives in petrol is not based on simple economic benefit but on directive decision of states. Most developed countries impose the duty to add ethanol or other components originating in agricultural production in fuels on the producers or suppliers of fuels directly in their legislations.

However, this is a game-changing reduction of risks associated with agricultural business. While the farmer cannot forecast the selling price of most agricultural products or the quantities of the produce that the market will accept (in some commodities with the exception of the European farmer; however, that is a farmer *sui generis* that does not exist in other geographical areas), many facts can be ascertained in advance with energy plants. Especially the purchase prices are usually clearly set even before the seed is planted. These plants are consumed by ethanol or other additive and fuel producers, i.e. clearly industrial operations. However, that means that to achieve reliable supplies, these operations will be mostly interested in regular raw material consumption. Therefore, they will have a natural interest in concluding long-term contracts. When biomass is combusted, for instance, it is clear that the power generated will be sold at a predefined price that is substantially higher than the price of power from other than renewable sources. Biomass combustion to generate heat or to heat water is always a closed production cycle not connected to the grid; therefore, the consumer must pay the set price because he has no choice.

That is exactly why the production of food is pushed away by energy-focused production. Price fluctuations and uncertainty of demand, common for foods, have been eliminated to a substantial degree in the area of energy plants; in addition, the influx of state aid to promote biofuels guarantees good profits in the entire industry.

In light of the foregoing, it will thus come as no surprise that under the influence of the rising impact of energy-focused agriculture, the entire system is undergoing deep and systemic changes that can be probably defined as essentially irreversible.

4 Czech Example: Development of Some Production and Profit Parameters

The Czech Republic has traditionally been a country that has achieved food self-sufficiency in all common commodities; with the production of most commodities substantially exceeding the demand and with exports receiving massive support before the accession to the European Union. Surplus was commonly seen in grain, butter and powdered milk, sugar and many other commodities.

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As we can see in Table 1, Czech agriculture must face two significant pressures at once. The first is the gradual decline of production and overall activity given by the low competitive ability of European agriculture and uneven conditions within the European Union. This is reflected in the shrinking of sowing areas, which witnessed a cut by one fourth between 1991 and 2011. The development in areas used to grow potatoes is a great illustration, with the 2011 figures representing only 23% of the 1991 figures. The speed of this decline is thus extraordinary, although a careful observation will reveal that the biggest declines were recorded in 1994, 1996, 2001 and 2002.

Table 1: Sowing areas of agricultural crops (Ha)

Year	Sowing area total	Potatoes	Rapeseed
1991	3 251 936	113 857	127 771
1992	3 209 673	110 726	136 473
1993	3 179 277	104 931	167 423
1994	3 117 625	76 789	190 721
1995	3 104 249	78 045	252 285
1996	3 068 362	86 548	228 775
1997	3 049 005	72 839	229 767
1998	3 041 966	72 087	265 560
1999	3 040 918	71 505	350 353
2000	3 020 564	69 236	325 338
2001	2 963 117	54 296	344 117
2002	2 686 078	38 311	313 024
2003	2 571 122	35 984	250 959
2004	2 665 713	35 973	259 460
2005	2 657 881	36 072	267 160
2006	2 585 685	30 024	292 246
2007	2 587 184	31 912	337 570
2008	2 568 630	29 788	356 924
2009	2 545 371	28 734	354 826
2010	2 495 859	27 079	368 824
2011	2 488 141	26 450	373 386

Source: ČSÚ 2012a [2]

Meanwhile, the area seeded with the key crop – wheat – shrunk by only about one tenth in the same period of time. However, this is to large extent due to the fact that a significant part of crop production is used to produce ethanol. Nevertheless, the area seeded with the key energy crop in Czech conditions – rapeseed – actually tripled. While rape was seeded on less than four percent of the total sowing area in 1991, it represented fifteen percent in 2011.

Therefore, Czech agriculture reached the viable limit – agrotechnical recommendations [3] suggest that rape should not be cultivated on more than 12.5% of all sowing areas, but may reach fifteen percent in extraordinary, and temporary, cases. If this share is exceeded, the quality of the soil will deteriorate. The 12.5% threshold has been exceeded for several years running in the Czech Republic, with the share of rapeseed gradually increasing. To illustrate: in 2007, rapeseed accounted for 13% of total sowing area, for 13.1% a year later, 13.9% the next year, 14.8% in 2010, ultimately reaching 15 percent in 2011, as mentioned above.

Comparing the development of rapeseed and potatoes will yield interesting results – these two crops essentially compete with each other in terms of soil, climate, amount of irrigation and other agricultural production parameters. We can say that rapeseed is doing the best in areas typically reserved for potatoes.

The decline in the sowing area for potatoes is so clear from the table that it makes no sense to further describe it – note that in 2011, potatoes were sown on about 23 percent of their 1991 area. This substantial decline is due to many specific reasons that bear no relation to rapeseed itself, including, without limitation, potato imports, consumer demand, quality requirements etc. Nevertheless, it is obvious that rapeseed is an important contributor to the fact that potatoes are being gradually pushed away from Czech agriculture.

Of course, this shift in agricultural production priorities is caused by economic and, above all, financial reasons. Looking at the development of the economic results of Czech agriculture in the past five years, we can see an interesting correlation between the rise of the rapeseed and the financial data.

Table 2: Relationship between areas sown to rapeseed, net agricultural operating surplus and financial output of rapeseed

Year	Share of rapeseed areas in sowing areas (%)	Net operating surplus (CZK mil.)	Financial output from rapeseed (CZK mil.)
2007	13.04	14 255.6	7 614.2
2008	13.09	14 586.2	9 004.0
2009	13.94	7 694.6	7 234.7
2010	14.77	12 731.3	8 384.6
2011	15.02	13 500.0*	9 200.0*

* - Estimate of authors based on preliminary statistical data (February 2012)

Source: ČSÚ 2012b [4]

As Table 2 indicates, rapeseed is an important stabiliser of the financial standing of agricultural businesses. While the sector must face dramatic fluctuations of net operating surplus, financial revenue from rapeseed shows great stability. In terms of agricultural production, this is due to the fact that rapeseed is a relatively resistant crop and

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the harvest shows relatively little dependence on the weather – rapeseed entails little risk compared to other crops. But above all, demand for rapeseed is stable due to the ongoing government support (both financial and primarily legislative) granted to rapeseed-based additives in diesel fuel. In addition, this support is not exclusive to the Czech Republic but marks a trend seen in all developed, rich countries: the European Union especially agile in this area, and in Germany, for instance, fuels from renewable sources enjoy significant popular support.

Given the high foreign demand that is related to the long-term strategy of the European Union, we can basically say that most of the Czech rapeseed production is exported and used for biodiesel production abroad, with Germany alone taking about 50 percent of the total Czech rapeseed exports.

5 Economic Limits and Benefits of Energy Agriculture

The preceding text gives rise to the two hypotheses that were suggested in the introduction.

The first hypothesis was the assumption that the development of energy agriculture has its natural limits defined by the area of land for agricultural use and by the nature of the crops, primarily by the capacity to grow the same crops repeatedly at one place. Therefore, we must clearly define the moment at which the demand for energy crops reaches the limits of its saturation.

Of course, there are many more energy crops than just rapeseed. For instance, some fast-growing tree species used for chip production are gaining ground in the Czech Republic. Chips are then either transformed into various types of pressed fuels (in the form of cakes) or are burned directly in heating or power generation facilities. These plants entail specific severe environmental risks [5]. Nevertheless, the case of the rapeseed shows another aspect: the increasing demand for rapeseed-based products, predominantly given by the duty to include bio-additives in fuels, i.e. by governmental decision, gradually leads to maximisation of rapeseed cultivation.

About 3.5 million hectares of land are available as sowing areas in the Czech Republic. The whole are was last used to its full capacity after World War II, i.e. in late 1940s.

Table 3: Development of used sowing area between 1920 and 2010 in the Czech Rep.

Year	Total sowing areas (mil. ha)
1920	3.813
1930	3.836
1937	3.835
1950	3.427
1960	3.383
1970	3.342
1980	3.317
1990	3.270
2000	3.020
2010	1.495

Source: ČSÚ 2012a [2]

If more land was in general use and if the maximum share of land was used to cultivate rapeseed, its sowing area may reach about 500 thousand hectares, i.e. about 130 hectares more than today. This means that Czech agriculture cannot increase its rapeseed production by more than about one third compare to the present figures without substantially increase rapeseed production per hectare.

Converting this to real numbers, with about 370 thousand hectares of land, rapeseed production reaches about 1.1 million tons. If we extended the production to 500 thousand hectares, which would exceed the level of long or medium-term sustainability in terms of healthy agriculture considerate to the lands, rapeseed production could reach about 1.486 million tons. Compared to total 2009 and 2010 production, that would be a roughly 35% rise.

This full-capacity situation cannot be exceeded if we follow the recommendations for correct agrotechnical procedures and crop mix. We must also bear in mind that rapeseed is in no case a purely energy-focused crop: it is widely used in the food industry and elsewhere, e.g. in the production of environmentally save oils and lubricants or oils in the food industry.

Now we must look at the development of the legislation that affects the demand for rapeseed methyl ester, i.e. diesel fuel additives. The legislation primarily includes various decisions on the EU level that bind each states to mix methyl ester fuels and diesel acquired from raw oil in a certain proportion.

In 2011, a statutory provision obliging oil-based diesel manufacturers to add more than five percent of biodiesel in the mix was essentially still in effect and was fulfilled [6]. This provision lead to a dramatic increase of areas sown to rapeseed on the European level – although the rise was not as pronounced as in the Czech Republic. The original 2003 Directive assumed that the proportion of methyl esters and other bio-additives in the fuels would increase up to about 20 percent by 2020 –

more precisely, it was assumed that renewable sources would represent twenty percent of the energy consumed for transport. New legislation was adopted following the 2008 dramatic rise of prices of foods and agricultural commodities in general and after a series of research studies that contested the general environmental benefits of mixing diesel with methyl esters [7]. Very simply speaking, the new document does not set out clear and explicit goals, but we can say that its fulfilment in 2020 would require mixing methyl esters with diesel in roughly a 1:9 proportion.

However, a simple increase of methyl esters' share in commonly sold diesel to eight or ten percent, which can be understood as value that has been declared the next gradual step by the European Union, will cause substantial pressure on increasing the area rapeseed fields, as we cannot assume the demand for rapeseed products in the food or chemical industry to wane away.

For instance, increasing the share of methyl esters in diesel to ten percent would mean that all the current Czech rapeseed exports would be consumed domestically. In other words, increasing the share of methyl esters in diesel to ten percent would mean the end of export opportunities for rape or rapeseed products. Increasing the share to twelve percent would either require imports or reinstitution of agricultural activity on parts of the fields that were excluded from the sowing areas in recent years (as we earlier expected when we sought to find the total production potential for rape seeds in the Czech Republic).

As we can see, the space for increasing rape products' share in diesel is limited, and the legislation now in effect, if complied with, essentially creates a significant demand impulse of a magnitude that reaches the capacity limits of Czech agriculture.

There is a real risk that agricultural businesses and farms that will be threatened by the instability in other production sectors, especially by the continuous and deep crisis of animal production, will continue to seek rescue in the cultivation of energy crops, regardless of the environmental risks and agrotechnical standards or recommendations.

And here lies the answer to the second hypothesis suggested in the introduction. We can deem proved the fact that at least in the conditions of Czech agriculture, energy crops are a significant stabilising element for these businesses. The reasons are twofold: their output per hectare is usually stable and foreseeable, which also applies to the key energy crop, rapeseed. Second, we cannot forget the fact that prices of these crops are governed by slightly different rules than common agricultural products. With the demand to substantial degree given e.g. by the applicable legal provisions on adding bio-components in diesel (or ethanol in petrol), the demand, or at least the minimum demand, can be forecasted to a point. As a result, the processors of rape, for instance, see farmers as standard raw material suppliers, simply as if they were coal suppliers. The sophistication and stability of contractual relations in this area of agricultural business is much higher than in any other area. However, this also indicates that there is some price setting that is again more stable and more resistant to fluctuations than normal. Another factor is at play here – both rapeseeds and especially rapeseed oil and other products store well and do not deteriorate quickly, which is a crucial fact that facilitates stabilisation of the entire chain.

However, all this means that if the assumptions of further increases of the share of methyl esters in diesel, as contained in Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC [7] come true, we must expect continuous pressure of farmers in the Czech Republic (and probably in many other EU member states) for increasing the areas sown to rapeseed over the limits defined by the applicable agrotechnical regulations and recommendations.

6 Conclusion

As general conclusion, we can say that many recent studies that focused on the true environmental benefit of biofuels and their impact on the reduction of greenhouse has creation and other air pollution were not thorough enough and did not cover the issue in its entirety.

It has been proved many times beyond any doubt that mixing additives in classic fuels is beneficial in this respect – many various studies have been published about that [8, 9]. Works have been published that map the origin of pollution in the combustion of fuels in engines and during the extraction of classic fuels or during the cultivation of agricultural crops and the processing of renewable sources with an astounding degree of sophistication [10]. These and other studies have motivated the European Union in recent years to adopt legislation that is more realistic and cautious in introducing biofuels, as it accepts the fact that the production of biofuels may in many cases cause

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damage that prevails over the benefit gained from their use.

Nevertheless, we must still expect substantial pressure for an increase of biofuels consumption, and especially for their mixtures with classic fuels, to survive the next ten years (at least until 2020 [7]). This will also entail corresponding pressure for growing production of energy crops with all the associated consequences, i.e. these crops will push away food production as fuel prices rise, and especially agricultural businesses will breach the principles of cautious and sustainable land management. It is a task for further research to assess these phenomena in economic terms and to incorporate their impacts in our general approach towards biofuels.

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