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Options for integrating environmental components in measuring the performance of the agricultural sector in the Czech Republic, Hungary and Denmark

The present study will examine the potential ways of integrating sustainability indicators into measuring the performance of agriculture. The appropriate ways of calculating the output of the sector including damages caused and benefits gained by agricultural production will be dealt with. First, ways of integrating the environmental components in the calculation of economic performance followed by attempts to investigate some environmental indicators will be made that could be applied in the comparison of the efficiency of the Danish, Czech and Hungarian agricultural sector.

INTRODUCTION

During the past few years, I have examined the ways of measuring the efficiency of agriculture, which actually is the source of increasing agricultural production, and searched for the potential ways of ensuring the sustainability of an ever intensifying agricultural production.

My research has been put into a new context because of the findings of a recent article, in which STIGLITZ explained that it is time to modify our views on economic growth and on the wealth of a nation (STIGLITZ 2009). At present, the per capita GDP figures are considered the most accurate way of measuring economic welfare, even though we are faced with a number of new phenomena which have a significant impact on our perception of well being. However, these phenomena are not part of the traditional macro-statistical accounts and are not reflected in the GDP measures. STIGLITZ refers to three important areas of consideration such as:

a) climate change, which is the consequence of pollution (it distorts the GDP measures because the current methodology does not take the degradation of the environment, of natural resources and of nature's assets into account
b) negative social phenomena, like the increasing income inequalities. If GDP is expressed in per capita figures, then, according to STIGLITZ, we might have false ideas about the general welfare of the citizens of a given country. In a country with an even distribution of income for example, the per capita national income, as the mean, can show a realistic picture of an individual's income, but with an uneven distribution, when the majority of the wealth is concentrated in the hands of a minority, a great number of people may live below the average income level.
c) growing share of the government sector, e.g. in education, health, infrastructure, (the problem is the value of output. It distorts GDP figures because their output is measured simply by the input values).

It has long been clear that GDP is an inadequate metric to gauge well-being. WEITZMAN, in his article published more than three decades ago, argued that the net domestic product is considered a good measure of wealth, while prosperity is the

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discounted value of future consumption, so human and natural capital should be included in capital stock (WEITZMAN 1976).

According to BARTELMUS and VAN TONGEREN (1994) an early indicator of the trends and limits of sustainable economic growth may be the replacement of GDP by EDP (Ecological Domestic Product) or the extension of the scope of key variables in the dynamic growth models

In February 2008, The Commission on the Measurement of Economic Performance and Social Progress (also known as the STIGLITZ Committee) was set up. The Commission's aim was to identify the limits of GDP as an indicator of economic performance and social progress, the development of more relevant and adequate indicators and the creation of alternative measurement tools with environmental and social dimensions and to check the feasibility of measurement tools proposed by the Commission (CMEPSP 2008).

In the present paper I am investigating how the requirement for sustainability could be integrated in the measurement of the performance of agriculture. First, the possibility of applying some indicators is discussed then in the empirical part, the efficiency of the agricultural sector of Hungary, the Czech Republic and Denmark is compared. Special attention is paid to the fact that Hungary and Denmark are traditionally considered agricultural countries, whereas the Czech Republic has been seen as an industrialized country. To gauge the efficiency of the sector, an input/output ratio is applied. The environmental damage caused by agricultural activities is illustrated by various indicators. The application of such indicators in the calculations aims to determine the possible differences in sectoral efficiency.

MATERIAL AND METHODS

I. National Accounts and the Environment

1. Green National Accounting

The conventional method of calculating national income figures is part of the United Nations System of National Accounts (SNA) and is still in use. SNA was introduced in 1968, and it was only in the 1980s that a new methodology was developed1. To discuss these issues, from the mid-80's to the early '90s, a number of meetings and conferences were held, for example, UNEP-WB had five workshops on the topic. The United Nations Statistical Division (UNSDA) has developed the framework of SEEA (System for Integrated Environmental and Economic Accounting) and the SNA was revised, which resulted in two major changes:

a) new definition of what they see as assets or in other words, property
b) there are recommendations formulated about a so-called satellite (additional) accounting system which integrates environmental and economic statistics into the conventional measurement of economic performance.

The "Handbook of Integrated Environmental and Economic Accounting" methodological handbook was developed with the aim of calculating the environmentally adjusted net domestic product, the so-called EDP (Eco Domestic Product). The sat-

[1] Many economists criticise the standard calculation of national income and dealt with the interrelationship between economic and natural assets, for further reference see Nordhaus-Tobin (1972), Gelb (1988), Harrison (1989), Hartwick (1990), Maler (1991), Hueting, R., Bosch P., de Boer B. (1992).

ellite accounts – while maintaining the SNA concepts and principles – integrate environmental data. In most OECD countries serious efforts have been made to establish green national accounting.

Conventional GDP summarizes a whole range of information about the economy in one number. GDP can show the comparative strengths and weaknesses of various sectors. It measures what an economy produces, i.e. *output and income*. GDP is thus an accurate barometer of the business climate. Despite the limitations of GDP, it has been widely used as an indicator of economic health and well-being of a nation and its society. GDP has become the de facto measure of progress that it was not considered as a sole point of reference which it eventually became.

The rise of environmentalism has been one of the main driving forces behind calculating alternative-indicators. Alternative measures of *welfare* are now available, e.g. the Genuine Progress Indicator (GPI), Index of Sustainable Economic Welfare (ISEW), Sustainable National Income (SNI), Gross National Happiness (GNH), and Human Development Index (HDI), Happy Planet Index (HPI), Sustainable Development Index (SDI), etc. Some alternative measures of domestic output and income are depicted in *Table 1*.

Table 1
Alternative indicators of domestic output, income and welfare (own compilation)

Name of alternative indicator	Main features of the indicator
GPI	Measures how well citizens are doing as individuals or communities both economically and socially.
ISEW	Monetary indicator of welfare and sustainability, (consumer expenditure balanced by non-financial factors like cost associated with pollution and other unsustainable costs) and covers areas such as income inequalities.
SNI	Maximum income with the technology in the year of calculation at which environmental functions remain available in a sustainable way.
GNH	Is used to rank life satisfaction and measures quality of life or social progress in holistic and psychological terms (physical and mental well being).
HDI	A summary composite index used to measure a country's achievements and to rank countries by level of human development.
HPI	A measure of environmental efficiency supporting well-being.
SDI	Statistical values that measure the capacity to meet present and future needs without compromising the ability of future generations to meet their own needs (calculated by adding Human Capital Index, Health Index and economically adjusted GDP).

2. Statistical problems and difficulties in the calculations

As AAHEIM and NYBORG pointed out, the calculation of EDP resulted in a number of difficulties (AAHEIM, NYBORG 1995). They concluded that depending on the method used, the results can be very different thus their interpretation can be difficult and it is easy to misinterpret the resulting net domestic product values. Such figures can not serve as a warning sign to intervene or as need for a stronger environmental policy.

Further difficulties arise in the method applied when calculating the value of environmental benefits and damage. In SEEA three methods for measuring the EDP are proposed. These various methods stem from the different possible ways of quantifying the deterioration of the natural environment: market value, cost recovery or a combination of market value and the willingness to pay.

Given that most environmental goods have no market, are not tradable, we do not have relevant direct information about their value, therefore, we get different figures if we apply different methods of calculation (AAHEIM and NYBORG 1995). To determine the value of natural resources, which are non-marketable goods, two approaches may be used: depreciation or user cost. The former one is proposed by HARRISON, who suggests that net domestic product should be deducted from the change in stock of natural resources: the value of extraction is deducted, however, this contains the income from this resource and depreciation as well (HARRISON 2002). Another solution may be to make an initial estimate of resources (assets) and the value of depreciation is considered to be the decline in assets.

II. Environmental indicators in the agricultural sector

1. Some environmental indicators with significant impacts on the environment

Slightly narrowing the issues above, this present paper considers which environmental impacts could and should be considered in calculating the output of the agricultural sector when examining the contribution of agriculture to the national product.

The potential indicators are classified into two broad groups:

a) agriculture increases the value of the environmental stock (natural wealth): for example, it keeps the soil in good condition, preserves the genetic resources of plants and livestock, preserves biodiversity, and does not pollute the environment (air, water, soil) by generating waste while providing employment and a livelihood for the rural population. The present study does not deal with the benefits of agricultural activity; it only deals with the destructive impacts on the environment and on the quality of life.
b) efforts should be made to minimize undesirable impacts to the environment, so in this group I suggest indicators that quantify the *negative impacts* of agricultural activities.

In modern agriculture, and in the developed countries in particular, the attention is focused on externalities. The reason, on the one hand, is that *environmental pressure*, the consequence of intensive production, became measurable, while *social tensions* (rising unemployment, deepening of income disparities) have deepened as a consequence of a slowdown in economic growth rates and particularly in today's crisis. The changing structure of the economy is manifested in the growth rate of the expanding service sector, and in which rural areas have to find their place by the diversification of rural activities, such as by the development of tourism or by the maintenance of traditional rural activities and by maintaining the landscapes.

As STIGLITZ puts it – the attempts to revitalise the world economy and to tackle climate change raise the question whether the traditional statistical indicators (development indicators) provide an appropriate signal for acting, since social and environmental factors are excluded (STIGLITZ 2009). Competitive economic activities and the expectations of the EU require an agricultural activity which

complies with the principle of sustainability. The environmental impact of agricultural activities, the levels of pollution and the environmental taxes, compensations and subsidies (to internalize the externalities) became an economic issue, which affect economic performance moreover, the impacts became quantifiable.

BALL, LEVELL, LUU and NEHRING highlighted the important role of integrating environmental damage (especially water pollution) and the beneficial effects resulting from agricultural activities into performance evaluation, namely in the calculation of productivity indices (BALL et al. 2004).

Based on the results of a previous study (BEKE, FORGÁCS 2010), through the example of Denmark, the Czech Republic and Hungary, I would like to introduce some of the environmental indicators that could be integrated into the measurement of the performance of agriculture. I examine what negative impacts agriculture has on the environment, and its effects on growth. By taking into account the methodology developed by BALL, LOVELL, LUU and NEHRING, I will depict the application of a number of indicators that express negative environmental impacts, which I believe represents the environmental damage caused by the agricultural sector and may significantly affect the sector's output.

Nitrogen balance is calculated as the difference between the nitrogen intake (the main inputs include volumes of nutrients as inorganic fertiliser, livestock manure, nitrogen fixation by crops and atmospheric deposition per hectare) and nitrogen output (the principle outputs include volumes of nutrients taken out by harvested crops and grass/fodder (EEA report, 2007). In Europe the volume of nitrogen input is significantly higher than the volume of the output.

The sources of *water contamination* (rivers, lakes, seas, and groundwater) are sewage, industrial activities, and in particular agricultural activities. The quality of water can be measured either directly by chemical analysis of water samples or indirectly by the level of the emission of pollutants (fertilizers, pesticides) (EEA Report).

The amount of *water abstracted* for agricultural purposes greatly affects the environment. The main areas of agricultural water use are irrigation, fish farming and animal husbandry. Irrigation and fish farming can be handled together, mainly because in Hungary they represent the greatest demand for the abstraction of surface waters. (Agricultural irrigation and fisheries are the main sources of water abstraction.)

Besides industry and transport, agriculture is the third largest pollutant. To measure *air pollution* the amount of greenhouse gas emissions was used.

Waste generated by agriculture includes the amount of manure from livestock, liquid manure, dead animals, vegetable waste, fishing and hunting. Waste can cause contamination indirectly e.g. air, water, soil contamination, can cause a stink or can evoke unpleasant aesthetic or visual effects.

2. Indicators used for measuring the efficiency of agriculture in Denmark, the Czech Republic and Hungary

In this present paper an attempt is made to compare the performance of the agricultural sector in selected countries in the year 2006. Only one year was taken into account since 2006 was the only year when sufficient amount of data generated by the same methodology were available for all categories. The efficiency of Denmark and two Central-Eastern European countries is compared – Hungary with strong agricultural traditions and the Czech Republic that has always been more industrialized.

To compare the *efficiency (i.e. the ratio of inputs and outputs)* of these countries, a six-category system is applied. In addition, based on the BALL, LOVELL, LUU and NEHRING methodology, environmental indicators were used to quantify the environmental damage caused by the agricultural sector (a 7th category is involved). The output is calculated as gross output at constant prices (Eurostat).

Table 2 shows all the inputs applied in the model, including traditional inputs as well as cultural and institutional factors considered as inputs to agricultural activities.

Table 2
Factors that impinge agricultural activities

Agricultural inputs	
Land	arable land and utilized agricultural area, croplands and pasture in hectares (Eurostat)
Capital	machinery, equipment (tractors, harvesting machinery, milking machine), animal stock (Eurostat)
Labour force	active workers employed in agriculture, the number of hours worked (AWU) (Eurostat)
Chemicals	Quantitiy of fertilizers and 5 pesticides (organic phosphates, herbicides, insects, fungicides and bactericides), the volume of mineral oils (FAO)
Technological indicators	
R & D expenditure	total expenditure on R&D as percentage of GDP (OECD, Eurostat and Danmarks Grundforskningsfond data)
Agricultural yields	Wheat yields, milk/cow, piglet/sow, eggs/laying hens (FAO, CSO, Dansk Landbrugsr adgivning Landscentret data)
Culture	
Education	only graduates from tertiary education (Agriculture, forestry and fishery) as the percentage of all graduates
Infrastructure	
Transport infrastructure	motorway density and density of railway lines (OECD and Eurostat)
Communication network	the proportion of households with home Internet access and phone subscriptions per 100 inhabitants (Eurostat)
Health infrastructure	Health expenditure % of GDP (Eurostat, WHO)
Institutions	
Confidence in institutions	parliament, judiciary, church, armed forces, police, social security, health care, civil services

Table 2 (continued)
Factors that impinge agricultural activities

Physical environment	
Number of sunshine hours	Statistical Yearbook 2009
Water resources	measured by the annual amount of precipitation (Statistical Yearbook 2009, KSH, Encyclopedia Britannica), and the available freshwater (Eurostat), measured
Temperature	running mean temperatures
Environmental pressure	
Nitrogen balance	Balance expressed as kg nutrient per hectare of total agricultural land area (OECD Factbook)
Water contamination	fertilizer use per hectare, and organic phosphates (Eurostat and FAO)
Water abstraction	water abstracted for agriculture (Eurostat)
Air pollution	greenhouse gas emissions by agriculture were examined (per capita CO_2 equivalent, tons Eurostat) (waste generated in agriculture hunting and forestry, tons per person, Eurostat)
Animal density	of live animals per unit area head/km^2 (FAO and Eurostat data), environmental pressure caused by manure (water and soil pollution), foul smelling substances, dust, microorganisms, ammonia (greenhouse gas) emissions and energy use.

RESULTS AND DISCUSSION

This present paper examined the performance of the agricultural sector in Denmark, the Czech Republic and in Hungary by applying a model in which besides the cultural and institutional factors, the environmental factors that can degrade the environment are involved in the calculation.

The main results are summarised in *Table 3* and *4*. As can be seen in *Table 3* Hungarian agriculture seems to be slightly more efficient than Danish agriculture. Efficiency is calculated by the ratio of the values for Denmark and Hungary (DK/HU) and for the Czech Republic and Hungary (CZ/HU) for the year 2006. When no data were available for both countries, then figures for 2004 were applied in the calculation. Since Denmark is a wealthy nation the input to agriculture in Denmark is higher than inputs in Hungary where the sector faces serious constraints. However, the difference in outputs is less significant (*Figure 1*).

The efficiency ratios (input per output figures) by factors applied in the calculation are depicted in *Table 3*.

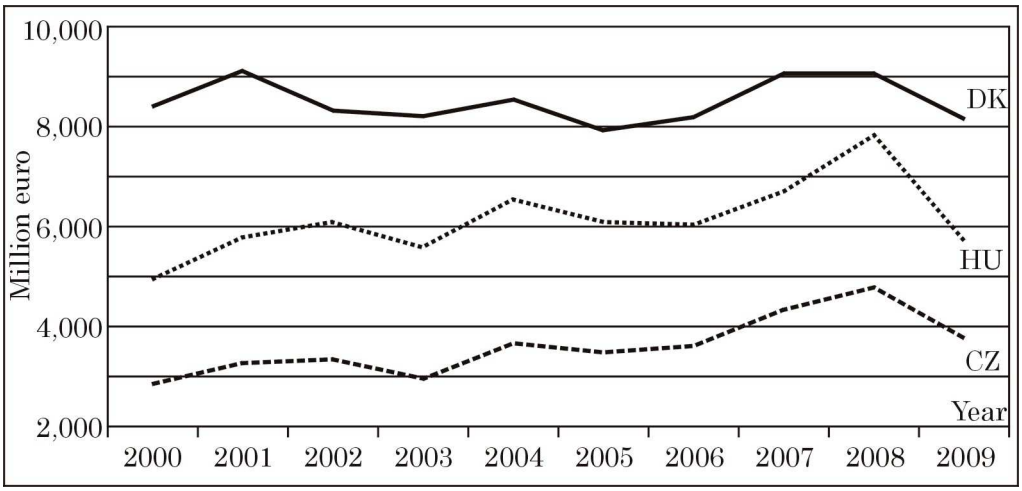

Figure 1
Agricultural output at basic price in the Czech Republic, Denmark and Hungary[1]

Table 3
Factors applied in calculating the efficiencyof the agricultural sector in Denmark, the Czech Republic and Hungary

Factors	DK/HU	CZ/HU
Education (weight: 0.1)	0.35	1.23
Infrastructure (weight: 0.1)	2.05	1.03
Technology (weight: 0.3)	2.16	1.33
Institutions (weight: 0.05)	1.20	0.94
Inputs (weight: 0.4)	0.73	0.71
Physical environment (weight: 0.05)	0.88	0.77
Weighted average of factors	1.284	0.994
Output	1.37	0.66
Efficiency	1.07	0.66

As it can be seen in *Table 3*, the values of the determinant factors are similar in Hungary and the Czech Republic, however, the output of the sector in the Czech Republic is only two thirds of the Hungarian output. The main difference is in the arrangement of the factors: e.g. technology is more developed in the Czech Republic (one-third more than in Hungary), the number of graduates from tertiary education (agriculture, forestry and fishery) as the percentage of all graduates is 25% higher in the Czech Republic. Institutional arrangements are similar, however, a significant difference in climatic conditions influences agricultural production.

[1] Source: own compilation based on Eurostat and KSH data.

In each year of the examined 10 year period, Czech agriculture was more productive in plant cultivation than Hungarian agriculture with higher crop yields. The yield per hectare figures are higher in the Czech Republic for most types of crops (e.g. rye, wheat, etc.). Although total yields, particularly wheat, sunflower and maize production, were higher in Hungary, the per hectare figures, that is the efficiency of production, was higher in the Czech Republic each year. Some preferred crops in the Czech Republic are potato, sugar beet or rye, while in Hungary corn production is ten times higher. *Figure 2* illustrates that in the Czech Republic average yields per hectar figures are higher than those in Hungary (kg/ha).

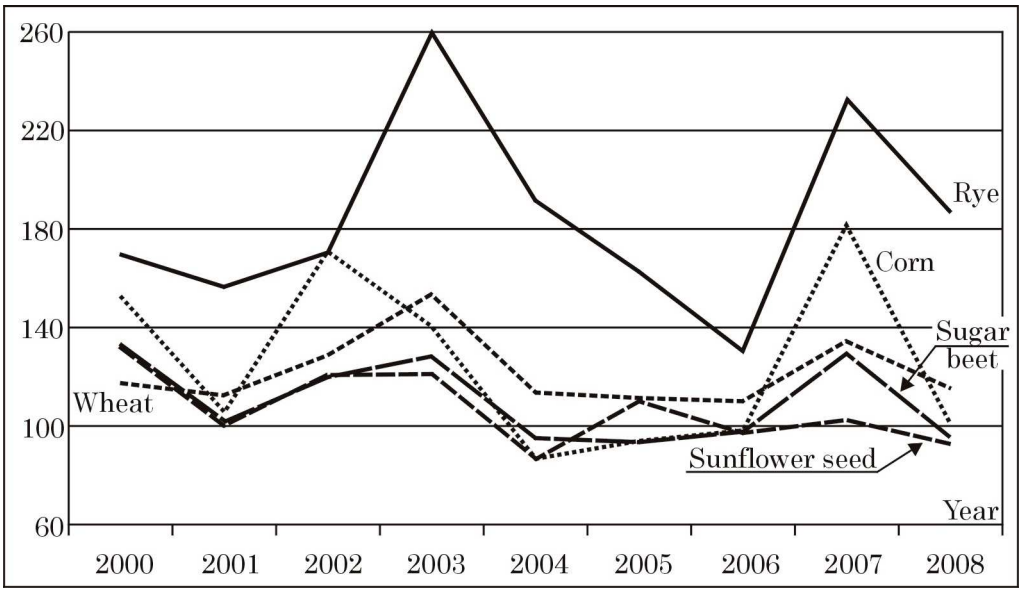

Figure 2
Crop yields in the Czech Republic (Hungarian values = 100)[1]

As can be seen in *Table 3*, in the Czech agriculture, input levels are lower, whereas thechnology is more advanced, which results in similar efforts. In crop production the Czechs proved to be more efficient, while in animal husbandry the efficiency of the sector is less productive than in Hungary. This is proved by the production figures, see *Table 4*. Meat production volumes per head in cattle and chicken is twice as big, while pig production figures are similar.

Table 4
Meat production rate (tonnes/head) 2000- 2008

	Cattle	Pigs	Poultry
Czech Republic	0.06	0.14	0.01
Hungary	0.13	0.16	0.02

[1] Source: own compilation based on Eurostat and KSH data.

Based on the findings of my recent studies, the difference between the performance of the Czech and Hungarian agriculture is hardly justifyable and further studies are necessary to prove whether the findings and results are valid and reasonable, however, the following summarising statements can be made:

1) The output of the Czech agricultural sector is two-thirds of the Hungarian outputs
2) The determinant factors are similar in number and quality, the difference is only in their arrangement and structure
3) As a consequence of the above mentioned facts, the Czechs should be less efficient (productive). Crop yields are higher in case of all the crops, meat production shows similar results, which might mean that the Czechs are less productive in animal husbandry. This assumption requires further investigation. Attempts will be made to find acceptable explanation to this finding.

When the environmental indicators are included in the model for measuring the performance of agriculture, similar results can be seen (*Table 5*).

The application of environmental indicators that express negative environmental impacts represents the environmental damage caused by the agricultural sector. These impacts may significantly affect the sector's output.

Fundamental differences were anticipated, however, the results are similar to the values received without the environmental impacts even when different weighted averages were applied.

Table 5
Factors including environmental pressure in measuring the efficiency of the agricultural sector in Denmark, the Czech Republic and Hungary

Factors	DK/HU	CZ/HU
Education (weight: 0.1)	0.35	1.23
Infrastructure (weight: 0.1)	2.05	1.03
Technology (weight:0.25)	2.16	1.33
Institutions (weight: 0.05)	1.2	0.94
Inputs (weight: 0.3)	0.73	0.71
Physical environment (weight: 0.05)	0.89	0.77
Environmental pressure (weight 0.15)	1.57	0.79
Weighted average of factors, weight A	1.284	0.994
Weighted average of factors, weight B	1.33	1.00
Output	1.37	0.66
Efficiency A	1.07	0.66
Efficiency B	1.03	0.66

The different weights applied in the calculation were:

weights in case “A” are	0.1	0.1	0.25	0.05	0.3	0.05	0.15
while weights in case “B” are	0.084	0.084	0.281	0.034	0.383	0.034	0.1.

In case of weight “B” the environmental factors received a significant 10% weight but the results were almost unchanged.

CONCLUSION

The concept of an environmentally adjusted measure of the performance of agriculture is a current issue since agricultural activities contribute to environmental degradation and have diverse environmental impacts which threaten to undermine the sustainability of agriculture.

This paper is concerned with the question of whether integrating environmental indicators in the inputs to agriculture will actually provide relevant information about the changes in efficiency and whether environmental components should be integrated into the calculation of performance.

Based on the results of this study environmental components incorporated into the measurement of the performance of the agricultural sector do not alter the results that were received without applying the environmental indicators. Environment-related input-output analysis is vital if the general welfare of a nation is assessed and if environmental degradation is highlighted.

Today, GDP per capita measures continues to be the main indicator for economic welfare and progress. The current system of national accounts neglects environmental resources unless they can be expressed in monetary terms or are marketable. Many of the "services" of nature (such as the work of wind, water) is free of charge consequently are not reflected in GDP measures. If the nation exploits its natural resources then it is included in the national income figures because they mean income and output. However, the degradation or destruction of natural resources is not counted in the national accounts.

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