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Statistics behind the agricultural total factor productivity in the EU

ABSTRACT

Accurate data is necessary to design policies that ensure food security and promote sustainable agriculture. This is one of the key policy goals at European and international level, including the United Nations Sustainable Development Goals. Measuring agricultural productivity by total factor productivity makes possible analysing agriculture in the light of the use of its producing factors. Additionally, it sheds light on the externalities produced by the agricultural industry. Different and coordinated actions are being taken within the international statistical community. This paper presents how to compile total factor productivity and sustainability indicators at European Union level.

1. INTRODUCTION

Harmonised agricultural statistics are available at European level since the middle of the last century for both, animal and crop statistics. The first EU level agricultural census took place in 1966. The agricultural census is an undertaking for collecting, processing and disseminating data on all farms and farmers in a country. It is carried out every 10 years as advised by the Food and Agriculture Organisation of the United Nations (FAO) and complemented by additional data collections called integrated farm statistics organised every 3-4 years.

The economic accounts for agriculture (EAA) available for EU countries since early 1970's. It is a satellite (extended) account of national accounts providing complementary information and concepts adapted to the particular nature of the agricultural industry. [European Commission (EC), Eurostat, 2024 1.07]

The [agri-environmental indicators](#) (AEI) track the integration of environmental concerns into the common agricultural policy at EU, national and regional levels. The data are available back to 1980s.

More and more voluntary data collections started in 1990-2020, like [Gross Nutrient Balance](#). This latter provides an insight into the links between agricultural activities and the environmental impact, identifying the factors determining the nutrients surplus or deficit and the trends over time.

By 2025, the European Agricultural Statistical System became fully harmonised and laid down by regulations:

- Integrated farm statistics (IFS): [Regulation 2018/1091](#)
- Statistics on Agricultural input and output (SAIO): [Regulation 2022/2379](#)
- Economic accounts for agriculture: [Regulation 138/2004](#)

These agricultural statistics may serve good basis for productivity indicators. Agricultural productivity has increased relevance, being second of the Sustainable Development Goal of the United Nations to end hunger, achieve food security and promote sustainable agriculture, became one of the specific policy objectives of Common Agricultural Policy (CAP) 2023-2027. [EC, Directorate Agriculture and Rural Development (DG AGRI), 2019]

Total factor productivity (TFP) is the ratio of the output growth to the change of the input factors producing it. These input factors are typically the land, labour, capital and the intermediate consumption (use of fertilisers (like nitrogen, phosphorus), pesticides, energy etc.). Currently TFP is applied as context and impact indicator in the [Performance Monitoring and Evaluation Framework](#) of CAP 2023-2027.

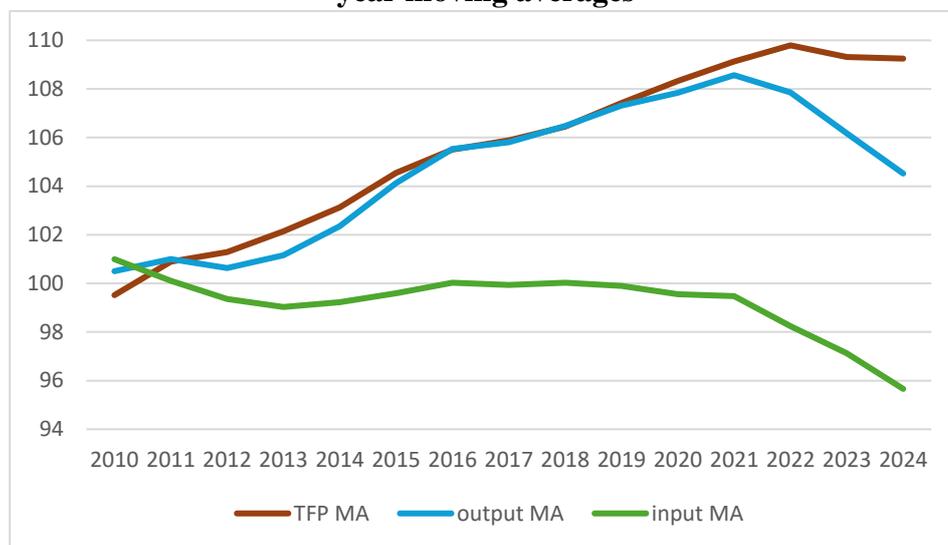
In recent years including sustainability aspect to the measurement is getting more and more important due to the increasing challenges in agricultural sector, like the effects of COVID or the Russian aggression in Ukraine or that of the climate change. The global objective is to incorporate sustainability together with productivity into appropriate indices that measure countries' agricultural sector performance, and in due course, create a (set of) sustainable productivity indicator(s). The relevance of sustainability is shown in its introduction in the new System of National Accounts 2025. Furthermore, it is included in EU's key priorities for 2024-2029.

2. METHOD

At European level total factor productivity is calculated as Fisher index by using economic accounts for agriculture (EAA) for output, intermediate consumption, agricultural labour input and capital, besides applying agricultural production statistics for land. [EC, DG AGRI, 2024] EAA is satellite (extended) account of national accounts following national accounts' structure and framework implementing a common set of accounting rules and assumptions. The TFP ratio concern the change of output compared to the change of input factors producing it. In order to smooth the weather shocks, data are introduced as 3-year moving averages. Figure 1 shows the evolution of the agricultural output, input and the total factor productivity over time. It can be observed that output has a growing trend while

input remains almost stable until 2021, thereby increasing TFP. From 2021, it is clearly shown that using less inputs has led to the production of less output that result in almost stable productivity growth.

Figure 1: Agricultural TFP index of EU-27 and its components, 2010=100, three-year moving averages



Source: DG AGRI based on Eurostat EAA data (online data codes: *aact_eaa04*, *aact_eaa05*, *aact_ali01*, *ef_mptenure*, *apro_cpnh1*)

The new System of National Accounts (SNA) released in 2025 define sustainable development based on Brundtland Commission Report: “meets the needs of the present without compromising the ability of future generations to meet their own needs. [UN, 1987]

The motivation for the development of SNA frameworks recognizes the potential of accounting-based approaches and the advantages of ensuring that data about the environmental and social dimensions can be readily connected to data from the SNA’s integrated framework. [UN, 2025 2.6] The relationship among the three aspects (economic, environmental and social) of sustainability is still under debate that reflects the different approaches of the social dimension. [EP, 2020]

‘From an accounting perspective, the link between well-being and sustainability can be reflected by recording monetary and non-monetary data across the economic, environmental and social dimensions using a common set of accounting rules and assumptions about how these benefits might change in the future.’ [UN, 2025 2.15] Therefore the most suitable way to integrate the environmental aspect in the calculation of TFP is integrating the environmental accounts. The upcoming European System of Accounts, which is currently being prepared following the 2025 SNA framework, may provide further insights.

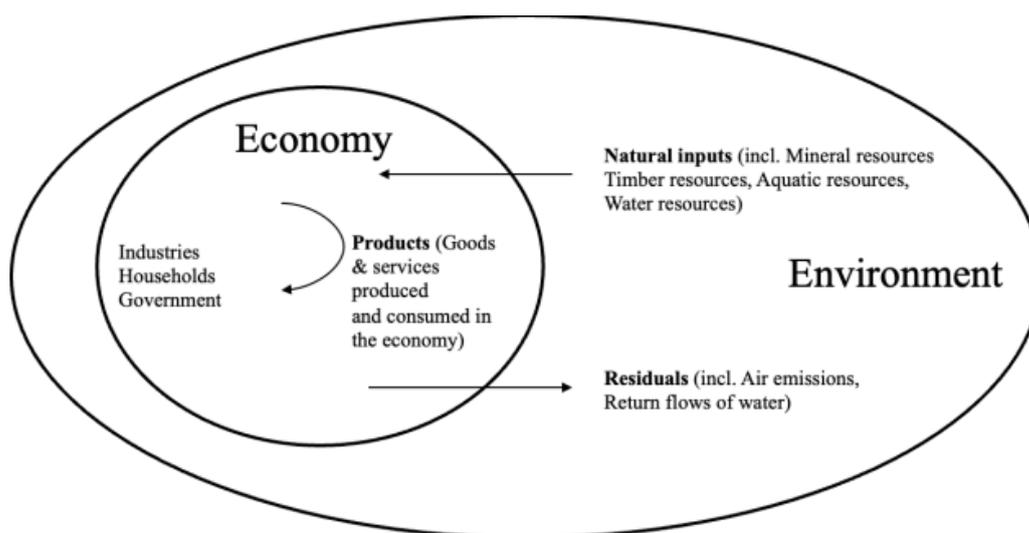
2.1. Environmental aspect

We need to capture environmental aspect under the same structure of national accounts to achieve a comprehensive indicator. This can be done by using environmental economic accounts (SEEA). This is an extended account of national accounts, ‘a multipurpose statistical framework that describes the environment and its connections to the economy.’

[UN, 2014 2.1] The four broad accounting areas of the system of EEA are [UN, 2025 35.43]:

- (i) accounting for natural resources (excluding land);
- (ii) accounting for land and ecosystems;
- (iii) accounting for environmental flows;
- (iv) accounting for environmental activities and transactions (e.g., environmental protection activity and environmental taxes).

Figure 2: Flows between the economy and the environment



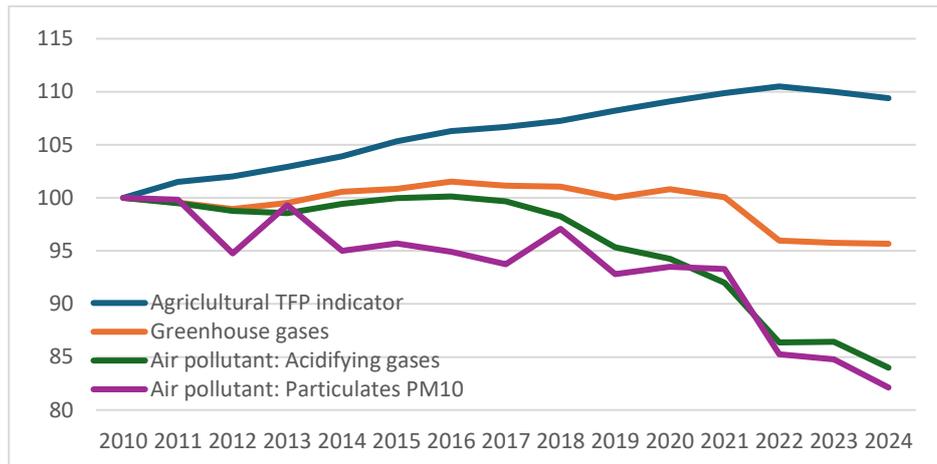
Source: UN (2014): SEEA Central Framework, figure 2.1

Environmental flows concern flows of substances such as water, energy, solid waste, air emissions, that move from the environment to the economy (natural inputs), within the economy and flows from the economy to the environment (residuals).

The air emission accounts (AEA) belong to the SEEA Central Framework main area of physical accounts, therefore following principles and rules of national accounts. They aim at describing the physical flows of gaseous and particulate materials from economy to the natural environment. They constitute simplified physical supply tables recording the flow of residuals originating from various economic activities, including agriculture.

Air emissions are incidental and undesired outcome of the economic system which are released to the atmosphere and remain suspended in the air for a substantial time period. Most of those residuals are in a gaseous state but small particulates and heavy metals are solids effectively suspended in the atmosphere for a substantial time and have certain behaviour similar to gases. [EC, Eurostat, 2015 16-18] AEA includes a selection of substances: six greenhouse gases (CO₂, N₂O, CH₄, HFCs, PFCs and SF₆ plus CO₂ emissions from the biomass as a separate item), five air pollutants (NO_x, CO, NMVOC, SO_x, NH₃) and two forms of particulate matter (PM10 and PM2.5). [EC, Eurostat, 2015 74] In the EU the air pollutants and greenhouse gas (GHG) emission produced by agriculture show declining trend since 2010 meanwhile the TFP indicator has a growing trend. (See figure 3.)

Figure 3: Agricultural TFP indicator and air pollution caused by agriculture, EU-27, 2010=100



Source: DG AGRI, EUROSTAT (online data code: env_ac_ainah_r2, air pollutants for 2024 own estimates)

To include the environmental dimension, we can consider it as “higher use” of input or as undesirable output. Here we included it in the input. Air emission accounts provide the volume change of GHG emission and that of main air pollutants. Cost of GHG and main air pollutants (EEA report ¹) is used as weight.

$$E_TFP_t^L = \frac{\sum o_t^L / \sum o_0^L}{\sum CI_t^L \times EI_t^L / \sum CI_0^L \times EI_0^L}, \text{ where } EI_t^L = \sum_m w_{m,0} e_{m,t}$$

$$E_TFP_t^P = \frac{\sum o_t^P / \sum o_0^P}{\sum CI_t^P \times EI_t^P / \sum CI_0^P \times EI_0^P}, \text{ where } EI_t^P = \sum_m w_{m,t} e_{m,t}$$

$$E_TFP_t^F = \sqrt{E_TFP_t^L \times E_TFP_t^P},$$

where:

O: output;

t: current year;

0: base year;

CI: conventional inputs;

EI: environmental pressure;

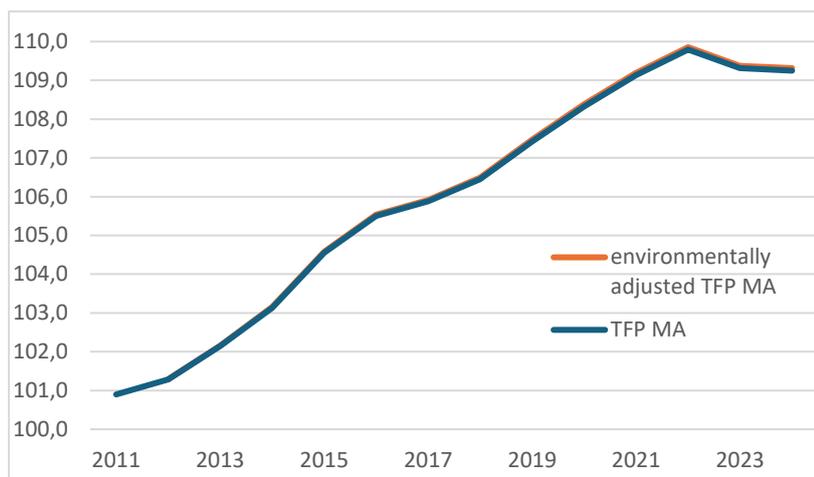
m: pollutant/emission ;

e: emission volume;

w: cost of air pollution.

¹ <https://www.eea.europa.eu/en/analysis/publications/the-costs-to-health-and-the-environment-from-industrial-air-pollution-in-europe-2024-update/t1-external-costs-from-industrial-air-pollution-by-pollutant-group-eu-27>

Figure 4: Conventional and adjusted TFP indicator of agriculture, EU-27, 2010=100 three-year moving averages



Source: Estimate based on DG AGRI, EUROSTAT (online data codes: aact_eaa04, aact_eaa05, aact_ali01, ef_mptenure, apro_cpnh1, env_ac_ainah_r2) and EEA data

By including the environmental pressure caused by GHG emission and air pollution coming from the agriculture, the TFP development was not significantly affected. The adjusted TFP indicator shows only a slight change as compared to the conventional TFP.

2.2. Social aspect

Social sustainability is generally related to maintaining a particular system or part of it for the human well-being intergenerational as well as intragenerational over the long term. [EP, 2020]

The broad concept of well-being of households is reflected in a mix of objective and subjective measures concerning well-being in the “here and now”, or current well-being, the well-being of future generations and the well-being of people elsewhere. [UNECE, 2014]

Objective measures of well-being include measures of various elements of people’s lives such as income, employment, housing, health, education, safety and social connections. [EP, 2020] The potential of the accounting-based approaches is in supporting the organization of relevant data, building linkages between macro and micro perspectives on material well-being (e.g., through the measures of household distributions of income, consumption and wealth and the measures of unpaid household service work), identifying stronger connections between measurement in the economic and social dimensions of overall well-being. The work is complex and ongoing in this field. Meanwhile there is potential to include this part of social aspect of sustainability in the total factor productivity indicator. The subjective measures of well-being concern self-reported well-being, which is out of scope of the SNA. [UN, 2025 34.11]

3. CONCLUSIONS

A TFP indicator in the EU is based on data following national accounting rules and structures. It can be extended by the environmental and social dimensions of sustainability

following the same structure and common set of accounting rules and assumptions as framed in 2025 SNA.

Concerning the environmental dimension the use of air pollution account would be methodologically consistent with the current TFP measure. This could provide methodologically comparable environmental adjusted TFP at EU level. Meanwhile the outlined adjusted indicator does not cover the solid and liquid pollution resulted by agricultural production. This would be the next step of our research.

Concerning the social aspect of sustainability, the 2025 SNA framework can be taken into account. The upcoming European System of Accounts that follow soon 2025 SNA may provide further guidelines in this field. Further research is needed to identify the details related to the agriculture.

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