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Received: 20.04.2021
Acceptance: 01.06.2021
Published: 29.06.2021

Annals PAAAE • 2021 • Vol. XXIII • No. (2)
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JEL codes: Q16

DOI: 10.5604/01.3001.0014.9098

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POTENTIAL IMPACT OF THE IMPLEMENTATION OF THE NEW GREEN DEAL IN THE FIELD OF MINERAL FERTILIZATION ON THE YIELD OF MAIN AGRICULTURAL CROPS¹

Key words: NPK, New Green Deal, Farm to Fork Strategy, CAP, yield

ABSTRACT. The aim of the article is to estimate the impact of reducing the consumption of mineral fertilizers resulting from the New Green Deal assumptions on the yields of major crops in the 2030 perspective. The material for analysis was statistical data from the CSO and FAO. The collected data was processed dynamically by using trend analyzes and Pearson linear correlation. Maintaining the current trend of increasing the dose of NPK mineral fertilization will allow the use of crop production potential in Poland. On the other hand, the introduction of the NGD assumptions may result in a stagnation of crop yield at the current level. However, in relation to the scenario assuming the continuation of the current upward trend, these yields will be much lower. Reducing mineral fertilization introduced by means of an administrative decision without taking the principles of rational management of fertilizer components into consideration may have negative environmental consequences.

INTRODUCTION

Fertilizers are widely used in agriculture to maintain soil fertility and increase crop yields. The application of fertilizers affects the chemical and physical properties of the soil and is an important procedure in modern agriculture. Fertilization allows for higher yields in less acreage and is, therefore, an important element in world food production [Gellings, Parmenter 2004, Piwowar 2013]. Besides fertilization, crop yields also depend on other agronomic inputs such as: pesticides, water, modern seeds etc. However, the

¹ Work funded under „Support of work related to the preparation of the CAP Strategic Plan for 2021-2027” from a budget grant allocated for the implementation of tasks of the Ministry of Agriculture and Rural Development in 2021.

yield depends, to the greatest extent, on the dose of the applied NPK mineral fertilization [Sattari et al. 2014, McArthur, McCord 2017].

However, fertilization may also have negative environmental consequences, related to e.g. the easy leaching of nutrients to surface and ground water [Koc, Solarski 2006]. The problem of rationalizing the use of nutrients (mainly nitrogen and phosphorus) is one of the important elements of the Farm to Fork Strategy, which is part of the New Green Deal announced by the European Commission. In line with this strategy, the Commission will take action to reduce nutrient losses by at least 50%, while ensuring that soil fertility is not deteriorated. As a result, this is expected to reduce the use of fertilizers by at least 20% by 2030 [EC 2020].

The aim of the article is to estimate the impact of reducing the consumption of mineral fertilizers resulting from the New Green Deal assumptions on the yields of major crops in the 2030 perspective.

MATERIAL AND METHODS

The material for analysis was statistical data from the Food and Agriculture Organization of the United Nations and Central Statistical Office of Poland database for the years 1991-2019 [GUS 2021, FAO 2021]. The collected data was processed dynamically by using trend analyzes, on the basis of which a forecast of changes in the consumption of NPK mineral fertilizers per ha of utilized agricultural land until 2030 was prepared. The criterion for selecting the type of the trend equation was the highest value of the determination index (R^2), which determines the degree of adjustment of the statistical model. For all analyzed parameters, the linear trend equation was the best fit. The standard error (SE) value was also calculated. It should be emphasized that the analysis refers to the medium-term perspective, where the usefulness of linear models is more useful than in the long-term perspective [Sroka, Musiał 2015]. Nevertheless, linear models are also used for long-term analyzes [Zhang, Zhang 2007].

The scenario assuming the implementation of the proposals contained in the New Green Deal (NGD) was also analyzed, which assumes a reduction in the consumption of mineral fertilizers by 20% by 2030. The 10-year period from 2010 to 2019 was adopted as the reference period, used to estimate the amount of reduction in the consumption of mineral fertilizers.

Based on Pearson linear correlation, the relationship between the consumption of mineral fertilizers in kg NPK/ha and the yields of the main crops, i.e. potato, sugar beet, maize for grain, wheat, triticale, rye, barley, oat and cereal mixture, was determined. Determining the direction and strength of the relationship allowed to estimate the impact of the assumed reduction in the consumption of NPK mineral fertilizers on the yields of the analyzed crops. The calculations were made according to the formula:

$$x = a \times ((1 - (b \times c)))$$

where: x – yield in the NGD scenario, a – yield from the trend equation, b – the level of fertilization reduction (20%) resulting from the assumptions of NGD, c – value of the correlation coefficient between the consumption of kg NPK/ha and the crop yield.

RESULTS

Based on analyzes, it was found that the implementation of regulations resulting from the New Green Deal (NGD) and the related Farm to Fork Strategy, regarding the reduction of mineral fertilizer consumption, will result in significant changes. Assuming a reduction in the consumption of NPK mineral fertilizers by 20% by 2030 in relation to the adopted reference period 2010-2019, it has been shown that the average level of fertilization will be 106 kg NPK/ha (Figure 1). This value is similar to the dose of NPK mineral fertilization that was used in Poland in the period directly preceding accession to the EU. The projected consumption of mineral fertilizers in line with the assumptions of NGD may be lower by as much as 39% (67.3 kg NPK/ha) in relation to the scenario assuming the maintenance of the current upward trend.

Such a large reduction in the level of NPK mineral fertilization must result in a reduction in the yield of agricultural crops. It may also deteriorate the nutrient balance and reduce soil fertility [Kopiński 2018]. However, it should be remembered that, according to many authors, reducing the consumption of mineral fertilizers can bring numerous environmental benefits, including reducing greenhouse gas emissions, improving water and air quality, and increasing biodiversity [Parlińska et al. 2020, Wrzaszcz, Prandecki 2020]. The correlation analysis showed a statistically significant, very strong to strong, directly proportional relationship between the discussed variables. The value of the correlation index for the fertilization dose kg NPK/ha and the yield of the analysed crops was as follows:

- sugar beet – 0.89;
- wheat – 0.81;
- rape – 0.76;
- potato – 0.71;
- triticale – 0.68;
- barley – 0.67;
- maize for grain – 0.62;
- rye – 0.61;
- oats – 0.48;
- cereals mixture – 0.42.

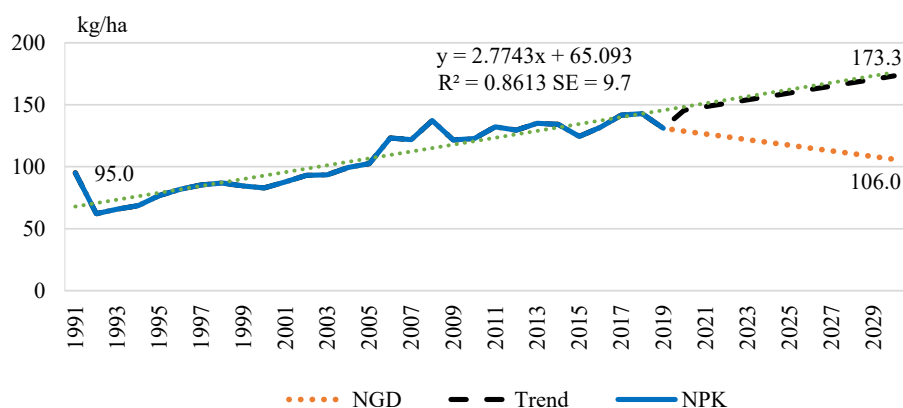


Figure 1. Current trend and forecast of changes in the consumption of NPK mineral fertilizers
Source: own study based on FAO and GUS data

It should be emphasized that a stronger interaction was found for crops of bigger market importance, i.e. sugar beet, wheat, rape and potato. On the other hand, the weakest, but also statistically significant interactions were noted for crops generally grown extensively, i.e. oats and cereals mixture.

The multi-year period (29 years) used in statistical analyzes allows for the assumption that the indicated relationships are permanent. In the scenario assuming the maintenance of the current trends, the yields of most of the analyzed crops will increase (Figure 2a, b and c). As in the case of the correlation coefficient, the highest values of the determination index (R^2) for trend equations were found for crops of the biggest market importance, i.e. sugar beet, wheat, rape and potato. Triticale, barley, maize for grain and rye were characterized by a slightly weaker upward trend. On the other hand, a very weak upward trend was found for oats and cereal mixtures.

In the scenario taking the introduction of NGD assumptions into account, the level of yields of all analyzed crops stagnated until 2030 at a level similar to that achieved in recent years. However, compared to the scenario assuming the maintenance of current trend and the strength of the relationship between the variables (correlation coefficient), the yields of all crops will be lower by: 18% sugar beet, 16% wheat, 15% rape, 14% potato, 13% triticale, 13% barley, 13% rye, 12% maize for grain, 10% oats and 8% cereal mixture. The presented analyzes result from the linear trend relating to the medium-term perspective and are burdened with the standard error (SE) of estimation. However, the values of this parameter and the determination index (R^2) indicate a satisfactory accuracy of the forecast. However, it should be remembered that the verifiability of the forecast of fertilizer consumption and changes in plant yield depends on many other factors, e.g. the implementation of technical and biological progress, changes in weather conditions, existing legal regulations, etc.

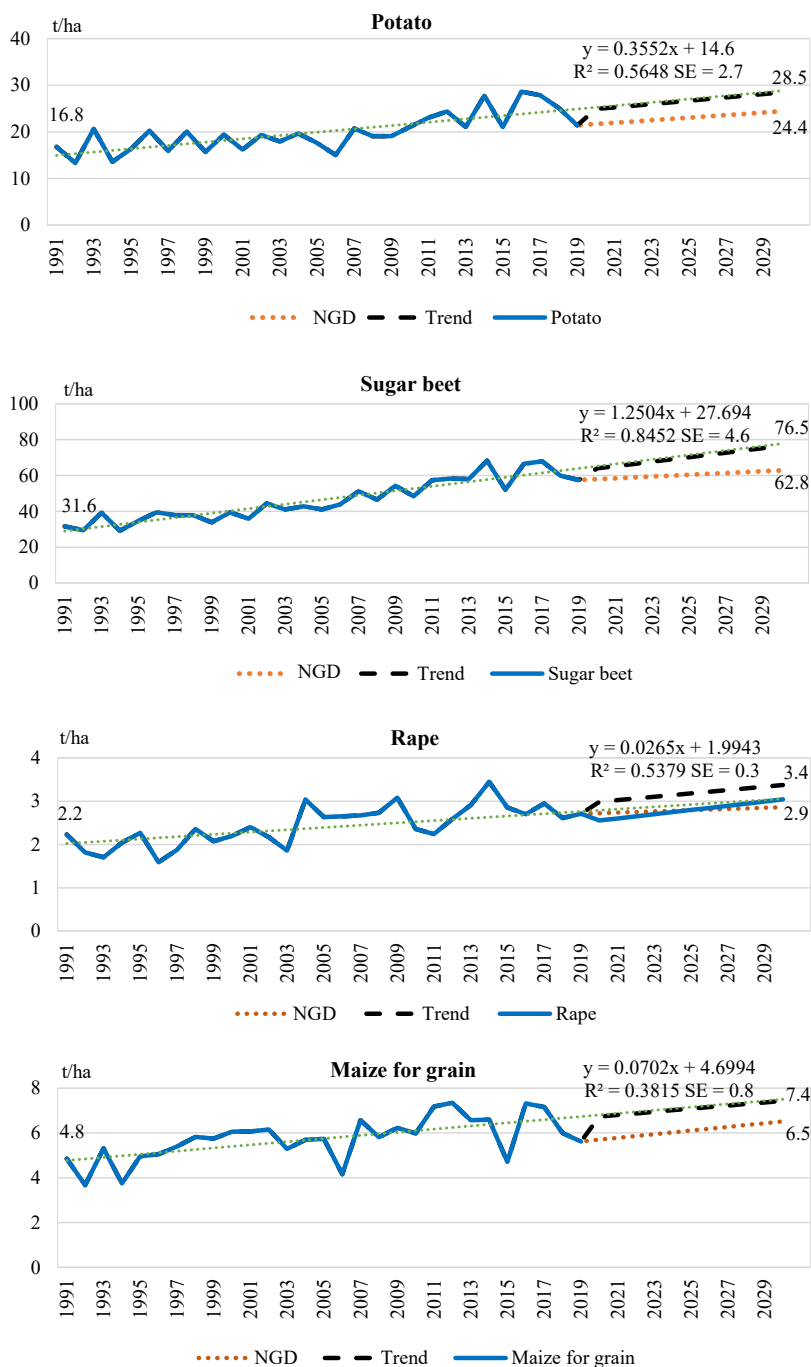


Figure 2. Current trends and forecast of changes in the yield of crops

Source: own study based on FAO and GUS data

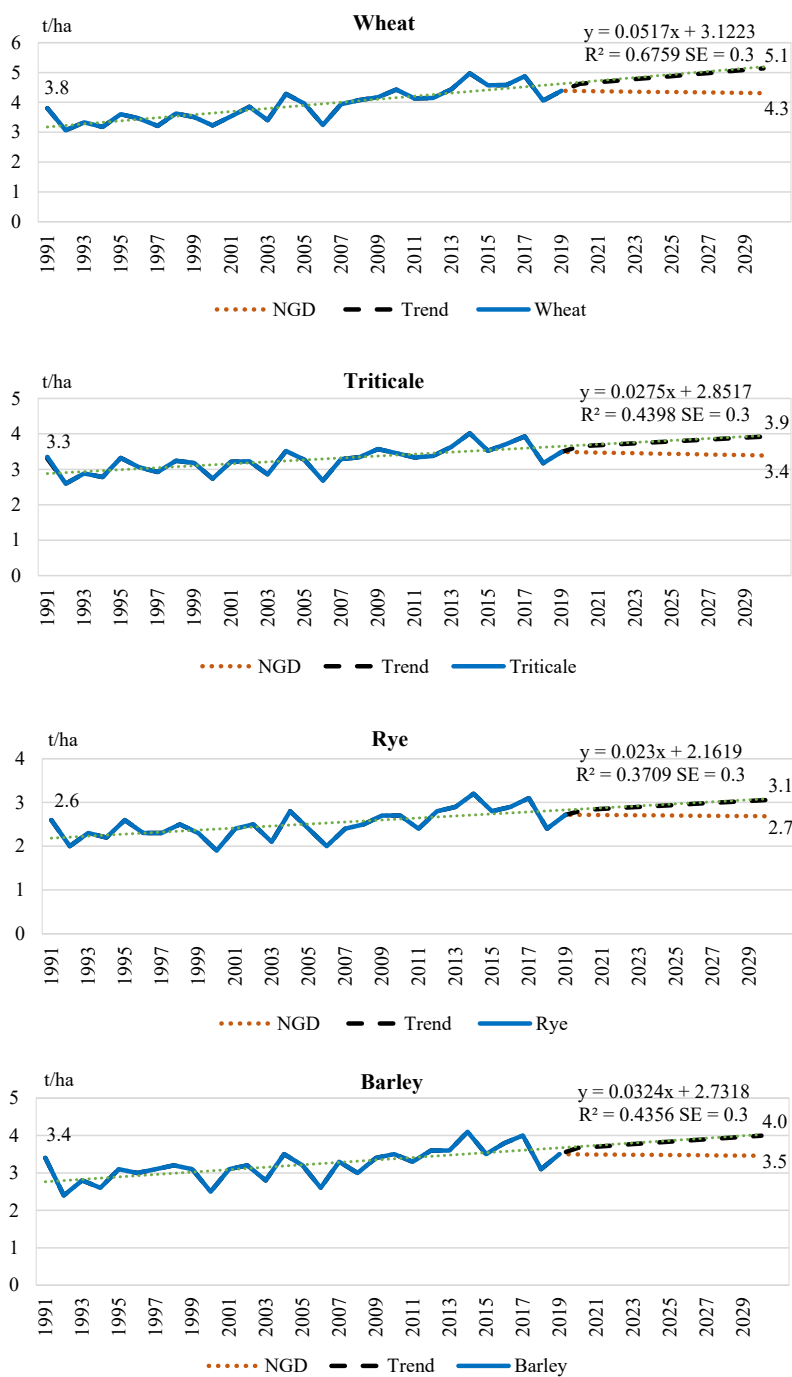


Figure 2. Continued

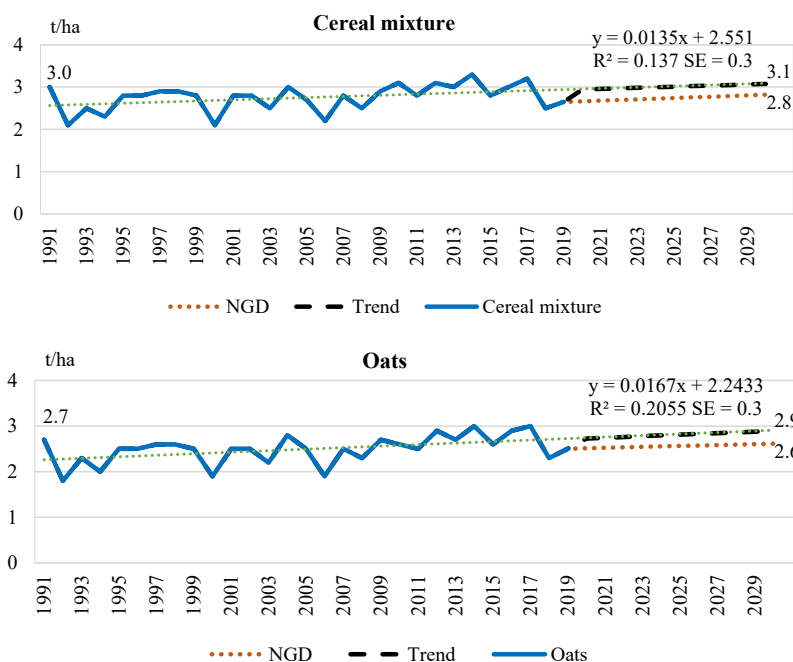


Figure 2. Continued

The development of agriculture in recent years has been based on an increase in productivity combined with the rationalization of the use of resources and a reduction of pressure on the natural environment [Adamowicz 2021]. However, the demonstrated significant reduction of crop yields resulting from the implementation of NGD may result in a decrease in food production, which will initiate a rise in its prices. As a result, increasing environmental benefits may be realized at the expense of production effects and social aspects.

CONCLUSIONS

The obtained results confirm the key importance of mineral fertilization in the context of increasing the yield of main agricultural crops. Maintaining the current trend of increasing the dose of NPK mineral fertilization will allow the use of crop production potential in Poland. On the other hand, the introduction of the NGD and the resulting Farm to Fork Strategy assumptions may result in a stagnation of the yield of arable crops at the current level. However, in relation to the scenario assuming the continuation of the current upward trend, these yields will be much lower. As a consequence, this may have negative consequences for self-sufficiency and food security.

It should also be emphasized that reducing the mineral fertilization of NPK by means of administrative decisions without taking the state of fertility of soils in P and K and the principles of correct nutrient balancing into account may bring negative, and not the expected positive, environmental effects [Montanarella, Panagos 2021].

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POTENCJALNY WPŁYW WDRAŻANIA NOWEGO ZIELONEGO ŁADU W ZAKRESIE NAWOŻENIA MINERALNEGO NA PLONOWANIE GŁÓWNYCH ROŚLIN UPRAWNYCH

Słowa kluczowe: NPK, Nowy Zielony Ład, Strategia od Pola do Stołu, WPR, plon

ABSTRAKT

Celem pracy jest oszacowanie wpływu ograniczenia zużycia nawozów mineralnych, wynikających z założeń Nowego Zielonego Ładu, na plony głównych roślin uprawnych w perspektywie 2030 roku. Materiały do analizy stanowiły dane statystyczne GUS i FAO. Zebrane dane były przetwarzane dynamicznie przy użyciu analizy trendów i korelacji liniowej Pearsona. Na podstawie przeprowadzonych analiz wykazano, że utrzymanie obecnego trendu zwiększania dawki nawożenia mineralnego NPK pozwoli na wykorzystanie potencjału produkcji roślinnej w Polsce. Z drugiej strony, wprowadzenie założeń NGD może skutkować stagnacją plonów na obecnym poziomie. Jednak w stosunku do scenariusza zakładającego kontynuację obecnego trendu wzrostowego, plony te będą znacznie niższe. Ponadto ograniczenie nawożenia mineralnego, wprowadzone decyzją administracyjną, bez uwzględnienia zasad racjonalnej gospodarki składnikami pokarmowymi może nieść za sobą negatywne skutki środowiskowe.

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