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SOCIO-ECONOMIC DEVELOPMENT OF AGRICULTURE BASED ON TECHNOLOGICAL CHANGE

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Abstract

Societies worldwide have faced different economic, environmental and social challenges in recent decades, including increasing population and consumption, shortages of natural resources, pollution and climate change. Agriculture is one of the most affected sectors. Considering its vital role as a provider of life-sustaining products and services, as well as business opportunities and employment for millions of people, we are responsible for finding solutions for its long-term development. For thousands of years, agriculture has grown in line with human civilization's growth. During its evolution, though, many negative externalities have become evident. Some resources disappeared; others were severely damaged or exhausted, threatening the food security of many countries or the whole world. The signals nature has sent us for years have become more and more serious. It is about time to change our philosophy of life and our social and economic models. It is time to focus on knowledge, science and innovations, good practices and experience, and new technologies.

The main objective of this paper is to summarize and present some of the most influential concepts of economic growth, analyze its dependence on innovations, and present the potential of new technologies to contribute to the social and economic development of agriculture.

Some of the analysis is focused on the theory of economic growth and the ways it can provide sustainable development. The factors influencing the continuing economic growth of agriculture are evaluated, and a methodology for assessing technological efficiency is also presented.

Keywords: economic growth, socio-economic development, technological change, sustainability

INTRODUCTION

One of the most important objectives of production and institutional systems on a micro- and macro level is to achieve economic growth. Generally, economic growth is the increase in the market value of the goods and services produced by an economy over time (Ivic, 2015). It can be measured in nominal or real (adjusted to inflation) terms. The main indicator for economic growth on a national level is the percentage change in the gross domestic product (GDP) or the gross national product (GNP). On a micro level, the economic growth of a company is related to the difference of performance in one year, compared to previous periods. Hayes (2020) has stated that economic growth could be positive or negative and in both cases, it reflects on the GDP and the GNP. The economic growth is positive when the value of production results in the period under consideration is greater than the value of results in the previous base period. If this is not the case, and the monetary value of the results in the current period is lower than that in the base period, the economic growth is negative.

Another important issue is how economic growth is achieved. There are two main types of growth, based on how the company or the economy as a whole uses production factors – extensive and intensive. This is noticed also in Wilczynski (1972). The

first option – an extensive growth is achieved when the increase in the quantity of output is based on the expansion of the quantity of inputs, such as land, water, labour, fertilizers, etc. For example, a farmer produces ***x***% more milk, but after increasing the herd by ***x***%, using ***x***% more feed, water, electricity and labour. Economic efficiency, in this case, does not change. Extensive growth was possible in the past when the world population was smaller, and natural resources were more abundant. Nowadays, arable land and labour are almost fully employed, and the demand for food and energy outweighs the capacity of natural resources to produce them. It is good for an economy to grow intensively and to maintain economic growth in the long run, especially per-capita.

Intensive growth is observed when the increase in the quantity of output is based not on the use of more production factors, but on a better efficiency of their exploitation. For example, suppose the farmer wants to increase milk production by ***x***%. In that case, he/she does not have to increase the herd numbers but to change the breed of the cows to a more productive one, to invest in new technology and machinery, to hire fewer but more qualified workers, to improve the management of the farm. By doing these, the farmer makes the production process more efficient and shifts the production possibility frontier outwards.

It can be summarized that economic growth is important and it should be guaranteed in the long term. There are various strategies that can be followed separately or in conjunction to optimize the base for economic growth. The possibilities are as follows:

- Invest in new technologies and increase the physical capital – land, machinery, infrastructure, tools, etc. For example, a farmer with a new and powerful tractor will cultivate more land than a farmer with an old tractor at the same time. New technology allows production of more outputs for the same time and with the same inputs.
- Increase in the number of workers. The more people employed – the more work can be done if all else is equal.
- Develop human capital, by education, training, qualification and practical experience.

In modern sustainable development theories, economic growth is substituted by economic development. According to Alfano (2014), there is a difference between economic growth and development, attributing to the latter a holistic definition, which takes into account additional factors, such as collective well-being, social equity, life expectancy, quality of institutions, and environmental quality. Economic development is a process focusing on both qualitative and quantitative growth.

MATERIALS AND METHODS

Historically different concepts for achieving economic growth and development have been emerging. One of the most articulated theory in this respect is the classical economic theory. According to this, production and growth are based on the law of variable proportions. Suppose one of the production factors is increased at fixed levels of the others and the same technology. In that case, production results will increase but with gradually diminishing returns, which at some point will stop and may accept negative values. The next step in the evolution of economic growth theory comes from the neoclassical concept. It does not reject the previous one but upgrades it. When the potential of one production system is reached based on the maximum exploitation of resources, there is still a possibility for continuation of growth based on technological change. Robert Solow and Trevor Swan in 1956 independently developed the neoclassical growth model, often referred as the "Solow-Swan growth model" (Dimand and Spencer, 2008). They introduced the model of long-run economic growth based on the influence of technological change and capital accumulation.

Significant for economic growth is education and knowledge development. This is reflected in the growth models of Romer (1986) and Lucas (1988), which constitute an important first core to the endogenous growth theory, in order to understand the characteristics to highlight the relationship between knowledge and economic growth and/or emphasize the importance of human capital in the growth process (Schiliro, 2006).

It is evident that people and societies want to live better, mainly by consuming more goods and services. Production of more goods and services depends on natural resources, human capital and man-made capital, technologies and knowledge. Natural resources are limited and exhaustible. Human needs and wants are unlimited. When considering the satisfaction of human needs, we have to consider not just the short-term interest of the individuals but the long-term interest of society. Modern societies have started to understand the greater importance of development over growth. Economists, natural scientists and policymakers are seeking ways to continue economic development, recognizing the limited potential of natural resources.

Natural resources in agriculture are all stocks of physical assets that are not produced by humans but are valuable to them. Natural resources are all natural conditions, wealth and processes that people value quantitatively and qualitatively and use in their lives or economic activities. If something exists in nature but people do not need, use or value it, this cannot be called a resource. The diversity of natural resources from an economic point of view, depending on the way they are used and reproduced, is divided into the following major groups:

- Inexhaustible are the resources with a relatively constant volume, the available quantities of which are independent of the rate of their consumption (solar energy, wind energy, sea currents, internal-earth energy, etc.);
- Exhaustible natural resources are:

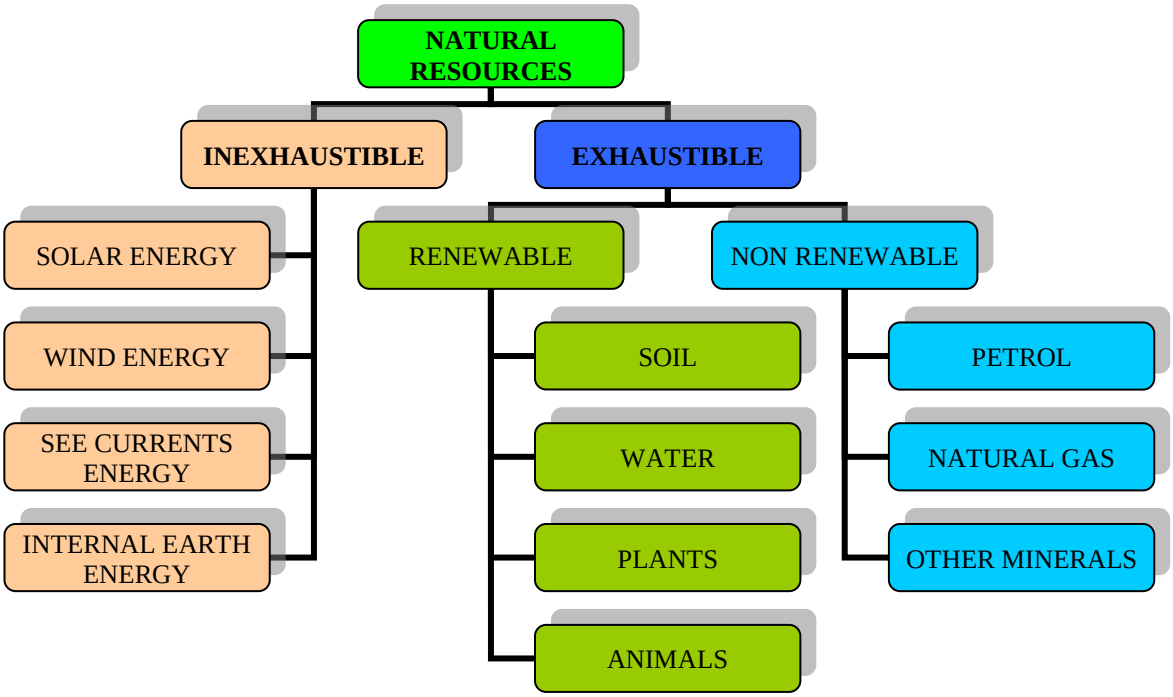

Fig.1 Classification of natural resources
Source: Own research 2023

Renewable – they have the potential to regenerate after being used. Their use is limited by the time needed for regeneration. Increasing the speed of use over the speed of regeneration is called overexploitation and leads to their depletion, reduction and disappearance. Renewable resources include soil, water, plants, animals, fish, etc.

Non-renewable – they are limited in nature and are unable to regenerate or increase. In the process of exploitation, their quantity is constantly been reduced and at some point they will disappear. Main resources in this group are petrol, coal, natural gas, different minerals, etc.

Natural Resources are essential inputs for economic and social development. However, their unsustainable use in the past had led to environmental degradation and resource depletion (Saum et al., 2018). Sustainable development of agriculture, industry, transport, tourism and any other industry largely depends on the country's natural resources. And because they are limited, the way forward is trough technological improvements and innovations.

THE ROLE OF INNOVATIONS FOR SUSTAINABLE SOCIO-ECONOMIC DEVELOPMENT

Innovations received theoretical conceptualization in the period 1960 – 1990 and in the 21-st century they were gradually transferred from the field of science to the field of management strategies and practice. In Schumpeter's classic interpretation, the technical evolution is defined as "a historical and irreversible change in the method of production". Such a change in practice can be achieved by: the use of new sources of raw materials; offering new products or ones of higher quality; implementation of new production methods; entering new markets; restructuring of production, etc. (Schumpeter, 1934). In the 1960s, innovations were mainly interpreted in "conceptual terms", without taking into account the complexity and diversity of definitions, and were generally seen in terms of companies rather than markets or countries (Carroll, 1967; Robertson, 1967; Mohr, 1969).

The Organization for Economic Co-operation and Development (OECD) has made a major contribution to the definition of innovation. In the so-called "Oslo manual" (2005), innovation is defined as "The introduction of a new or significantly improved product (good or service) or process; a new marketing method or a new organizational method in business practices, in the workplace, in the organization or in external relations" (OECD, 2005).

It can be summarized that the purpose of innovation is to create added value and have a positive impact on the work and development of organizations. Innovation as a value-adding concept is very important for the performance evaluation. In this context, it can be defined as a source of competitive advantages and considered as a decisive factor for economic growth and as an important condition for the development of the company in a competitive environment (Johannessen, 2009).

Technology improves the efficiency of production, which increases supply and lowers prices. As knowledge of new and more efficient methods of production become available, technology changes. New technologies in a particular industry allow firms to use labour and capital more efficiently. Innovations are the driving force behind economic efficiency. An improvement in technology usually means that fewer and/or cheaper inputs are needed to achieve the same results, or that using the same amount of inputs guarantees better results. For the economy as a whole, an improvement in technology shifts the production possibilities frontier to the right. Graphically the effect of innovations in the processes is shown with an upward shift of the production function (Fig. 2) or a downward movement of the production cost (Fig. 3).

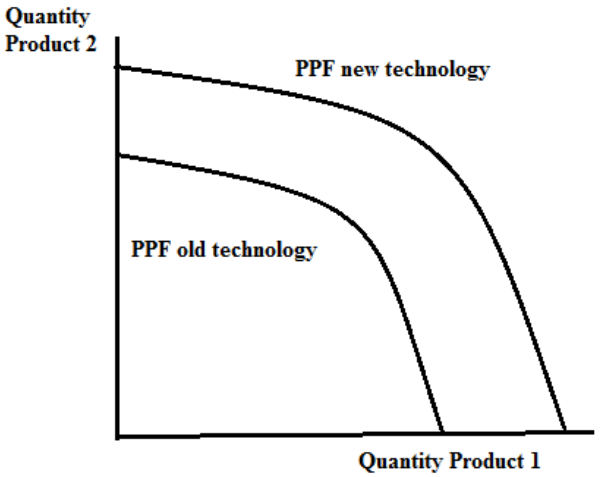

Fig.2 Production possibility frontier
Source: Own research 2023

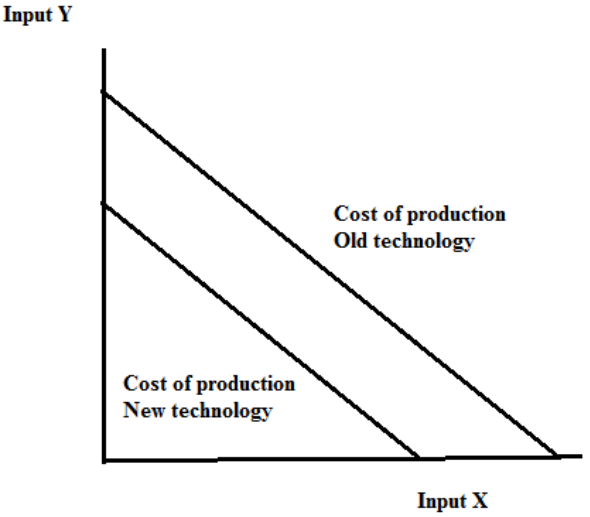

Fig.3 Production cost
Source: Own research 2023

If ***x*** and ***y*** are two factors of production, and each of them has a quantity and price, by introducing the new technology the production system will either have higher output for the same cost or will achieve the same level of output with reduced cost.

Farming methods have evolved over the years, from basic, hand-held tools to modern sophisticated machinery. Nowadays, technology is significantly helping growers and farmers in several ways, including precise forecasting, data-driven decision making, and more. The following technologies have contributed to the efficiency of agriculture: online resources and databases, global navigation and satellite systems, mobile devices, sensors, drones, variable rate technologies, etc.

Internet based technologies give farmers access to information, decision making tools, and solutions. Navigation systems provide the precise location of farm machines on the field's surface and allow for the optimization of plant protection chemical, fertilization, irrigation etc. Farmers can use variable-rate technology (VRT) to distribute the precise amount of inputs on the field. Mobile applications can help them to collect information, to check the weather, to take decisions. When these technologies are in use individually or in combination as an integrated ecosystem, the farm could be called "smart" or "precision".

The rate of diffusion of the available technologies though is not as fast as the rate with which they have been created. Farmers are relatively conservative on the adoption of new technologies.

Some of the obstacles to the implementation of new technologies in agricultural practice are related to their complexity, unproven efficiency, the need for serious investments and qualified staff that can understand and work with them. Farmers need to be sure that the new equipment is technically and economically efficient. There is no unique or standard framework for all farming systems and all conditions, but in the following part of the article a simple methodology that can be used for evaluating the economic efficiency of new technologies is presented.

METHODOLOGY FOR EVALUATING THE ECONOMIC EFFICIENCY OF NEW TECHNOLOGIES

In practice different approaches and methodological instruments exist and can be used for different purposes. For the assessment of the efficiency of new tools or a technological change a simple but at the same time accurate

technique can be applied. This methodology is based on the partial budgeting, as a method for comparing the costs and returns from a proposed change in a farm business. It is especially useful for evaluating a specific, limited change with what is currently being working. For example, a partial budget would be a good way to evaluate the costs and returns of a new tractor, combine, machine, etc. Suppose the new combine costs less to operate than the current combine, and is expected to harvest ***x*** more kilograms of corn/hectare due to less loss. The partial budget provides a consistent framework for comparing the lower operating costs and increased revenues from the new combine to the cost of buying the combine. Partial budgeting is an excellent way to evaluate whether a new technique or a piece of equipment will benefit farmer's operations. To use partial budgeting and evaluate the efficiency of the technological change, the farmer has to give answers to the following questions:

1. What new or additional costs will be incurred?
2. What current costs will be reduced or eliminated?
3. What new or additional revenue will be received?
4. What current revenue will be reduced or lost?

Table.1 Partial Budget Format

Question: Invest in a new combine or keep the current one	
Reduced Revenue	Additional Revenue
Additional cost	Reduced cost
(A) Total Costs = (Additional Costs + Reduced Revenues)	(B) Total Benefits = (Additional Revenues + Reduced Costs)
Net change in profit = (B – A) = …….. $ Benefit/Cost Ratio = B/A = …….	

Source: Own research 2023

The decision could be either to buy a new combine or keep the current one.

Additional Costs are those costs that will be incurred with the new technique, method or enterprise. The new equipment usually has two types of costs: operating costs (getting new qualified staff or training of current staff) and ownership costs (amortization, paying interests to the bank or higher opportunity cost – missed income from the invested money, insurance, etc.). Both are important factors in accurately determining the profitability of an alternative.

Reduced Revenues are current revenues that will be lost or reduced should the new alternative be adopted. Not all alternatives will have reduced revenues.

Additional Revenues are those that will be received only if the new alternative is adopted. As with Reduced Revenues, not all alternatives will have Additional Revenues. But if decision is made to invest, probably the new technology will guarantee higher revenue.

Reduced Costs – the difference between the operating and ownership cost of old technology and the operating and ownership cost of new technology, if the new alternative is adopted. As with Additional Costs, both operating and ownership costs need to be considered.

For example, replacing an old combine with a new combine means that both the operating and ownership costs incurred from the old combine will be eliminated.

Costs: the Additional Costs and Reduced Revenues are the costs of the new alternative. These can be considered as the detriments of the new alternative. Benefits: the Additional Revenue and the Reduced Costs are the benefits of the new alternative.

Net Benefits: if the Benefits are greater than the Costs, the new alternative has positive net benefits. Any alternative with negative Net

Benefits should not be considered, as it will cost more than it will return.

Benefit/Cost Ratio: looks at the relative values of the benefits and costs.

Both Net Benefits and the Benefit/Cost Ratio should be used to evaluate the results from a partial budget.

CONCLUSION

Sufficient production of quality food is vital for any society. Agriculture is the primary producer of food and fiber. It has the responsibility to organize and use in the best possible way all natural resources, human resources and capital in achieving food security and sovereignty. This task in recent years is becoming more and more challenging. In ever changing economic, political and social environment, combined with pollution problems and climate change agriculture must continue to produce in accordance to the rising world population.

In conditions of limited natural resources, technologies have been the major driving force for increasing agricultural productivity and development together with innovations, entrepreneurship and education. The long-term development of the farming systems depends on their willingness and potential to adopt new technologies, innovate their production processes and update knowledge and human capital. Obviously there is no unique system that can be identified as sustainable and no single path to sustainability. However, it is important to recognize that the most sustainable farming systems are innovative; they invest in new technologies and education. In the economic theory and practice different concepts for sustainable development of farms and businesses can be found and adopted. Diverse methodologies for economic efficiency are also available and could be suitable for farmers or entrepreneurs for evaluating and assessing their performance or their decisions to invest in new technologies.

REFERENCES

Alfano, M. R. (2014). Economic Growth. In: Backhaus, J. (eds)л *Encyclopedia of Law and Economics*. Springer, New York, NY. https://doi.org/10.1007/978-1-4614-7883-6_49-1

Carroll J. (1967). A Note on Departmental Autonomy and Innovation in Medical Schools. *The Journal of Business,* 40(4*), 531–534.*

Dimand, R. W., & Spencer, B. J. (2008). Trevor Swan and the neoclassical growth model. *History of Political Economy.* https://doi.org/10.1215/00182702-2009-019, *42 (supliment 1). https://www.researchgate.net/publication/5188933_Trevor_Swan_And_The_Neoclassical_Growth_Model*

Hayes, A. (2020). Negative Growth: Definition and Economic Impact. *online at: https://www.investopedia.com/terms/n/negative-growth.asp*

Ivic, M. (2015). Economic growth and development, *Journal of Process Management – New Technologies, International*, 3 (1), 55-62.

Johannessen, J. A. (2009). A Systemic Approach to Innovation: The Interactive Innovation Model, *Kybernetes,* 38(1/2), 158–176.

Lucas, R.E. (1988). On the Mechanics of Economic Development. *Journal of Monetary Economics, 22, 3-42.*

Mohr, L. B. (1969). Determinants of Innovation in Organizations. *American Political Science Review*, 63(1), 111–126.

OECD (2005). Oslo Manuals. Guidelines for Collecting and Interpreting Innovation Data. *3rd Edition, https://doi.org/10.1787/9789264013100-en*

Robertson, T.S. (1967). The Process of Innovation and Diffusion of Innovation. *Journal of Marketing, 31, 14–19.*

Romer, P. (1986). Increasing Returns and Long-Run Growth. *Journal of Political Economy, 94(5): 1002-1037.*

Saum, A. M., Baldi, M., Gunderson, I., & Oberle, B. (2018). Articulating natural resources and sustainable development goals through green economy indicators: A systematic analysis. *Resources, Conservation and Recycling*, 139, 90-103.

Schiliro, D. (2006). Economic growth, knowledge and human capital. Theories and models of endogenous growth by Paul Romer and Robert Lucas. *Online at https://mpra.ub.uni-muenchen.de/52435/*

Schumpeter, J.A. (1934). The Theory of Economic Development: An Inquiry Into Profits, Capital, Credit, Interest and Business Cycle. *Transaction Publishers ISBN: 0-87855-68-2*

Wilczynski, J. (1972). Extensive and Intensive Growth. In: Socialist Economic Development and Reforms. Palgrave Macmillan, London. https://doi.org/10.1007/978-1-349-01255-8_2