Stępień S.
PhD in Economics, Associate Professor of the
Department of Macroeconomics and Agricultural Economics
Poznań University of Economics and Business
Smędzik-Ambroży K.
PhD in Economics, Associate Professor of the
Department of Macroeconomics and Agricultural Economics
Poznań University of Economics and Business

ARE SMALL FARMS SUSTAINABLE AND TECHNOLOGICALLY SMART AT THE SAME TIME? EVIDENCE FROM POLAND, ROMANIA AND LITHUANIA

Sustainable agricultural development, as defined by FAO in 1987, consists of using natural resources and orienting technologies and institutions in such a way as to meet current human needs and those of future generations [1, pp. 142-162]. This mode of agricultural development does not degrade the environment, ensures the conservation of soil, water resources, plants and animals, while meeting production targets and ensuring a decent quality of life for rural communities [2, pp. 34-39]. Sustainable development is an objective of strategic importance in the European Union. To date, many publications have been produced on the impact of agricultural practices on rural sustainability [3, 357-360; 4; 5]. These publications point to the beneficial effects of modern agricultural technologies on increasing land productivity and labour productivity, improving the quality of natural resources, ensuring food security, poverty reduction, among others [6, pp. 1-6; 7, pp. 4377-4383; 8, pp. 1-16]. It can be assumed that the application of modern technology using artificial intelligence (AI) contributes to the economic, social and environmental sustainability of farms. The implementation of such innovations is justified in the case of small farms, which, depreciated in the food supply chain as a result of the market mechanism, which leads to an income disparity in relation to

large farms [9; 10; 11]. The use of artificial intelligence solutions can improve their financial performance. On the other hand, some authors indicate that the adaptation of innovative solutions in small farms may be hampered by the lack of knowledge, skills and capital [12; 13; 14].

The aim of the study was to assess the level of use of modern technologies (artificial intelligence) in smallholder farms in Poland, Romania and Lithuania. These are three European Union countries, belonging to the so-called post-Soviet block, with a fragmented agrarian structure as a result of a similar path of systemic transformation. The study included units with a relatively high index of economic, social and environmental sustainability. Thus, the authors asked whether there is a synergy between sustainability and the degree of adaptation of modern technologies. At the same time, the rationale for using innovative solutions and the barriers associated with it were indicated. This made it possible to formulate recommendations for agricultural policy regarding the implementation of artificial intelligence in the smallholder sector. The study used a rare qualitative research approach - in-depth interviews with farm owners - which is a kind of contribution to the analysis of the phenomenon. The questions and statements found in these interviews fit into the theory of reasoned action (TRA), which is a psychological theory that links beliefs to behaviour. This approach includes the following components of human behaviour: knowledge, subjective norms and individual's behavioural intention. It was assumed that behavioural intention is the most proximal determinant of human behaviour [15, pp. 11-39; 16]. To the best of our knowledge, there are no similar studies for Central and Eastern European countries, hence it was reasonable to conclude that the paper fills a research gap in this area.

Small-scale farms from three countries – Poland, Lithuania and Romania – were included in the analysis. For this research, the following criteria were adopted to select these units: utilized agricultural area up to 20 ha UAA, standard output up to EUR 25,000 and at least 75% of the family members' labour input involved in agriculture activity. In the first stage, the analysis was based on surveys conducted in Poland in 2018 and in 2019 in two other countries. The samples numbered 710 farms

in Poland, 1000 in Lithuania and 900 in Romania. A purposeful and random selection of the research sample was applied. Data were collected in the form of direct interviews by agricultural advisors. Questions concerned four areas: general farm features, economic and social issues, environmental aspects and connections with the market. In the second stage, using these data, we ordered farms according to the synthetic sustainability measure. From each country, we selected the 20 most sustainable farms (the so-called 'Top-20'). Among these entities, direct in-depth interviews were conducted. The interviews took place in 2020 and involved authors and agricultural advisors. Therefore, in total, detailed information was collected from 60 farms from Poland, Romania and Lithuania.

The conducted research proved that the level of use of modern technology in small farms, even those with a high sustainability index, was in practice zero. Thus, it can be stated that small-scale sustainable farms in Poland, Romania and Lithuania are not technologically smart at the same time. This fact manifests the necessity of dedicating artificial intelligence-based solutions to small farms. This is especially true for countries with a high share of smallholder agriculture and a fragmented agrarian structure, as the low scale of production and land area, in addition to high acquisition costs, are considered as the main barriers to the application of AI. Therefore, instruments for subsidising the purchase of technology are recommended, in the case of EU countries these may be targeted funds under the second pillar of the Common Agricultural Policy. The barrier of too small scale of production and lack of capital can also be reduced by developing systems of cooperation in the purchase and use of innovative machinery and equipment (e.g. creating and disseminating a model of a kind of technology co-ownership agreement). It is also postulated that rural areas should be covered by broadband Internet and that farmers should be guaranteed access to powerful computers connected to Cloud and data. Last but not least, it is crucial to organise (e.g. at the headquarters of agricultural advisory centres, chambers of agriculture, village halls) a series of training courses on the application of artificial intelligence in agriculture, with particular emphasis on small farms. This process

should involve representatives of companies producing the technology, IT specialists, scientists, social partners and, finally, farmers using such solutions.

List of references

1. Bastan R., Khorshid-Doust R., Sisi S.D., & Ahmadvand A. Sustainable development of agriculture: a system dynamics model. *Kybernetes*, 47(1), 2018, pp 142-162. doi.org/10.1108/K-01-2017-0003
2. Allen P., Van Dusen D., Lundy J., & Gliessman S. Integrating social, environmental, and economic issues in sustainable agriculture. *American Journal of Alternative Agriculture*, 6(1), 1991, pp. 34-39. doi:10.1017/S0889189300003787
3. Diamond J. The rise and fall of the third chimpanzee. *Journal of Social and Evolutionary Systems*, 16(3), 1993, pp. 357-360. https://doi.org/10.1016/1061-7361(93)90040-X
4. Foley J.A., De Fries R., Asner G.P., Barford C., Bonan G., Carpenter S. R., & Chapiet F.S. *Global Consequences of Land Use. Science*, 309(5734), 2005. https://doi.org/10.1126/science.1111772
5. Siqueira T.T., Gallian D., Nguyen G., & Bánkuti, F.I. Organizational Forms and Agri-Environmental Practices: The Case of Brazilian Dairy Farms. *Sustainability*, 13(3762), 2021. https://doi.org10.3390/su1307376
6. Zha J. Artificial Intelligence in Agriculture. *Journal of Physics: Conference Series*, 1693(012058), 2020, pp. 1-6. doi:10.1088/1742-6596/1693/1/012058
7. Eli-Chukwu N., & Ogwugwam E.C. Applications of Artificial Intelligence in Agriculture: A Review. Engineering. *Technology and Applied Research*, 9(4), 2019. pp. 4377-4383. DOI:10.48084/etasr.2756
8. Mhlanga D. Artificial Intelligence in the Industry 4.0, and Its Impact on Poverty, Innovation, Infrastructure Development, and the Sustainable Development Goals: Lessons from Emerging Economies? *Sustainability*, 13(5788), 2021. pp. 1-16. https://doi.org/10.3390/su13115788

9. Guth M., Smędzik-Ambroży K. Czyżewski B., & Stępień S. (2020). The Economic Sustainability of Farms under Common Agricultural Policy in the European Union Countries. *Agriculture*, 10(2), 2020. https://doi.org/10.3390/agriculture10020034
10. Smędzik-Ambroży K., Matuszczak A., Kata R., & Kułyk P. (2021). The Relationship of Agricultural and Non-Agricultural Income and Its Variability in Regard to Farms in the European Union Countries. *Agriculture*, 11(3), 2021. https://doi.org/10.3390/agriculture11030196
11. Czyżewski B., Czyżewski A., Kryszak Ł. The Market Treadmill Against Sustainable Income of European Farmers: How the CAP Has Struggled with Cochrane's Curse. *Sustainability*, 11(791), 2019. https://doi.org/10.3390/su11030791
12. Cook P., & O'Neil F. Artificial Intelligence in Agribusiness is Growing in Emerging Markets. *International Finance Corporation*, note 82, 2020.
13. Tanghe T. Boosting the use of Artificial Intelligence in Europe's micro, small and medium-sized Enterprises. Brussel: The European Economic and Social Committee, 2021.
14. Renda A., Reynolds N., Laurer M., & Cohen G. Digitising Agrifood: Pathways and Challenges. Brussels: CEPS&BCFN, 2019.
15. Ajzen I. From intentions to action: A theory of planned behavior. In: J. Kuhl & J. Beckman (Eds.), Action control: From cognitions to behaviors. New York: Springer, 1985, pp. 11–39.
16. Fishbein M., & Ajzen I. Predicting and changing behavior: The reasoned action approach. New York: Psychology Press, 2010.