IMPACT OF SUSTAINABLE DEVELOPMENT ON AGRICULTURAL COMPETITIVENESS: HOW MOLDOVAN AGRICULTURAL PRODUCTS CAN MAKE A DIFFERENCE ON THE EUROPEAN MARKET

DOI: https://doi.org/10.53486/dri2025.18
UDC: 338.43(478):061.1EU

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Abstract. *European consumers are increasingly concerned about environmental challenges and, benefiting from a wide range of alternatives, they prefer to opt for those perceived to have the least negative impact on the environment or society in general. In this context, the main objective of this research was to examine the relationship between competitiveness and sustainable development, with particular emphasis on the aspects that need to be considered to increase the competitiveness of Moldovan agricultural products, which constitute a major component of the country's exports to the European Union. The research confirms the findings of other authors that there is a direct interdependence between competitiveness and sustainable development. Therefore, to reach a high competitiveness level for its agricultural products, the Republic of Moldova must implement measures that promote both environmentally sustainable and climate-smart agricultural practices, as well as better working conditions and a decent income for people involved in this branch of economy. This includes the adoption of advanced technologies such as precision agriculture, which can contribute to better products with less unwanted residues, at the same time helping to decrease the need for intensive manual labour, thereby lowering production costs and improving workers' wellbeing. Another important aspect to be considered is obtaining the necessary certifications that can confirm the adherence to good agricultural practices and social responsibility standards which are a crucial component expand the exports of Moldovan agricultural products to the EU market.*

Keywords: *competitiveness, sustainability, Moldovan agriculture, greening of agriculture, smart farming, climate smart agriculture, certifications in agriculture.*

1. Introduction

The accession of the Republic of Moldova to the European Union opens huge opportunities for the domestic agricultural sector, which is one of the main pillars of the national economy, contributing to near half of the country's exports of goods.

The EU is one of the largest consumer markets globally: the constituting countries have a total population of about 450 million all of them characterised by high GDP per capita. On the other hand, the EU has a very competitive agricultural market, especially if to consider that its agricultural production is estimated at over 10% of the world's total, while just 5.5% of the world's population lives in the EU (Eurostat 2024).

Within the current context of abundant consumer goods and relatively stable income levels, European consumers have raised product standards to levels that surpass those observed in many other global regions. Given the extensive range of available options, purchasing decisions are increasingly based not only on the physical attributes of the goods but also on their associated or perceived social and environmental impacts. In this framework, contemporary European consumers tend to define product quality in terms of confirmable evidence that the product has been produced without imposing negative effects upon the environment, employees, or society as a whole.

This paradigm shift is also reflected in product labelling practices. In Western European retail environments, in addition to traditional labels emphasising sensory or organoleptic qualities (e.g., "Great Taste"), an expanding array of logos, such as the EU Ecolabel, Organic, Fair Trade, Rainforest Alliance Certified, among others, is prominently displayed. These labels serve as indicators that the products meet certain environmental or social benchmarks, thereby aligning with evolving consumer expectations.

Concurrently, heightened concern over climate change has been institutionalised within a specific

regulatory framework. The European Climate Law, which entered into force on 29 July 2021, mandates that the European Union achieve net-zero greenhouse gas emissions by 2050, with an interim objective of reducing emissions by at least 55% by 2030 relative to 1990 levels. This policy environment has encouraged numerous producers to pursue "net zero" operational targets, signalling their commitment to a more sustainable economic model and leveraging these achievements within their marketing strategies.

Another notable trend in Western markets is the growing scrutiny of natural resource efficiency. Beyond considerations of carbon footprint, consumers are increasingly attentive to factors such as the volume of water utilised in the production of agricultural goods when making purchasing decisions. Although the Common Agricultural Policy currently promotes sustainable water management practices in agriculture, it still does not require the indication of water usage metrics on product labels. Nonetheless, evolving market dynamics may well precipitate the future adoption of such requirements.

In contrast, the Moldovan agricultural sector faces significant challenges amidst these tightening European market requirements. Climate change in Moldova has intensified the need for effective irrigation practices, which must prioritise not only efficient water use but also the preservation of water quality to mitigate soil degradation – a concern that is further exacerbated by often feeble land management practices. Moreover, rural areas in Moldova are experiencing a pronounced labour shortage, stemming from both population aging and rural exodus. The delayed implementation of modern agricultural technologies has resulted in low labour productivity and reduced income levels, thereby diminishing the sector's appeal to younger people. Without an accelerated transition toward smart farming practices, the long-term prospects for Moldovan agriculture remain uncertain.

In light of these observations, the present study seeks to elucidate the relationship between sustainability and competitiveness in the context of Moldovan agricultural exports. The primary objective is to outline key strategic measures that can enhance the competitiveness of Moldovan agricultural products, thereby facilitating their continuous and successful marketing within the European Union.

2. The relationship between sustainability and competitiveness in economic theory

The analysis of the specialised literature on competitiveness reveals the definition of this term evolved in time. Classical theories viewed competitiveness mostly from the point of view of some tangible properties, which make one product sell better than another, one industry develop faster than another, one country be more prosperous than another, etc. Thus, Michael E. Porter believes that "The only significant concept of competitiveness at the national level is productivity" (Porter, 1990).

According to the above definition, it would appear that the Moldovan agricultural sector will be more competitive the more it can ensure a higher productivity. Despite the undoubtful validity of this statement, yet it does not reflect all the facets of competitiveness, which seems to be a much more complex subject, as it may be suggested by the introductory part of this article. Thus, it is important to also take into account the cost of ensuring this high productivity.

Competitiveness has a dynamic nature and to ensure a superior degree of competitiveness in long term, high productivity in agriculture should not lead to soil degradation, depletion of aquatic resources or any other damage caused to the environment. High competitiveness, likewise, cannot be a purpose in itself, but it have to result in certain benefits. In this context, Stephane Garelli offers a definition of competitiveness that also encompasses aspects related to sustainability: "The competitiveness of nations is a field of economic theory that analyses the facts and policies that shape the ability of a nation to create and maintain an environment that supports more value creation for businesses and more *prosperity for its people*" (Garelli, 2012). Garelli's definition also seems visionary from the point of view that it addresses not only environmental aspects, but also human well-being. High competitiveness level based on cheap labour, which keeps the country's population near the poverty line, just like the one obtained at the cost of resource depletion or environmental pollution, does not present too much value when viewed in the long term (Cimpoieș, 2024).

Competitiveness is important, but equally important is the sustainability of competitiveness. In this sense, stands out the slogan under which SolAbility, a consulting company specialised in the field of sustainability, publishes its Global Sustainable Competitiveness Index: "What is not sustainable is not competitive; What is not competitive is not sustainable." (SolAbility, 2024).

3. Strategic directions to reach a sustainable competitiveness of Moldovan agriculture

Greening agriculture and the transition to climate-smart agriculture

The EU remains is one of the largest organic markets globally, following the USA and being ahead of China. In 2023, the European market for organic products (eco or bio, depending on the preferred term in a particular country) was estimated at around 46.5 million Euros, and the land under organic production amounted to 17.7 million hectares (IFOAM Organics Europe, 2025). According to forecasts, the growth rate on this market is expected to exceed 10% annually up to 2032, with Germany, France and Italy being the countries with the most significant development in the field (IMARC, 2024).

For the Republic of Moldova, which is striving towards EU integration, these trends could present considerable opportunities, but despite some momentum in the first decade of the millennium, Moldovan organic agriculture has entered a phase of stagnation. If in any Western supermarket there are specialised sections, or at least a clear distinction is made on the shelves for organic products, in the Republic of Moldova it is quite difficult to identify a certified organic product. Thus, we can see that organic products represent only an extremely narrow niche on the domestic market.

One of the reasons for stagnation in development in this area was that terms like "eco" or "ecological" have being used for ages in an arbitrary manner for uncertified products, what demotivated many producers to make additional expenses to obtain organic certification (AID, 2015). Unfortunately, the awareness of the general public about the true meaning of organic products remains low and under these conditions the market for certified organic products is not formed yet.

Another problem results from the shortage of inputs for organic agriculture, especially disease-resistant varieties. Therefore, Moldovan farmers produce organically either field crops and nuts that are intended for export, where this certification is required, or crops that by their nature do not require treatments with synthetic substances.

If organic farming can be considered a "desirable" option that can add value to local products on international markets, then the transition to climate-smart agriculture has already become a pressing necessity, as the country is already going through various climate challenges year after year (spring frosts, lack of precipitation, arid summers).

Climate-smart agriculture allows not only to adapt to environmental conditions that are constantly changing, but by adopting innovative practices and technologies that allow increasing the productivity and overall resilience of the sector, these practices also imply reducing greenhouse gas emissions, which naturally must slow down the progression of climate change.

Frost busters and heating elements powered by wind turbines already proved to be efficient in mitigating the risks related frost in several perennial plantations in Moldova. Therefore, to boost the adoption of these technologies, respective state policies should be elaborated, and government support is needed.

Another important aspect to be considered by Moldovan farmers is to improve the water management following the principle of "getting more crops from the same drops". In this regard, is important to use the most suitable irrigation systems for particular crop, focusing mainly on drip, sprinkler or subsurface irrigation and smart systems that would ensure the most efficient water usage. Similarly, rainwater collection and improved drainage systems can help reduce groundwater waste and optimise water use.

Adaptation strategies also entail changing crop mix and developing of new varieties with increased resistance to drought, pests and diseases. Such measures are particularly relevant in the Republic of Moldova, where increasing aridity, scarcity of precipitations, new diseases and reducing outturns of traditional crops require alternative options to maintain yield levels.

The transition to climate-smart agriculture further involves the implementation of conservation agricultural practices. For instance, no-till technology, contrary to conventional deep ploughing methods, minimises soil disturbance, thereby preserving soil structure, moisture, and organic matter content. Crop rotation, as another conservation technique, contributes to sustained soil health, mitigates erosion, and enhances carbon sequestration. Moreover, the integration of forest strips within agricultural landscapes serves to augment biodiversity, provide wind protection, and promote moisture retention, which collectively contribute to improved soil fertility.

Rotational grazing practices have been shown to produce higher-quality forage, leading to improved animal health and increased livestock productivity while simultaneously enhancing waste management and reducing emissions from livestock operations. The adoption of organic fertilisers and bio-pesticides within this framework not only improves soil quality but also reduces dependence on synthetic chemicals.

Finally, integrated pest management, which synergistically employs biological, mechanical, and chemical strategies, provides a sustainable method for pest control that minimises environmental impacts.

Collectively, these climate-smart agricultural strategies represent a cohesive approach to improving both the resilience and sustainability of agricultural systems in the face of changing environmental and climatic conditions.

Precision agriculture

The application of precision agriculture can also increase the sustainability of the sector. This approach is based on the use of various high-precision sensors, as well as data analysis tools that offer the possibility of automating processes and making informed decisions on the fly. Precision agriculture has a special role in streamlining the production process, saving time, effort and material resources through more efficient management of inputs (such as fertilisers and irrigation water, for example), but also a lower consumption of pesticides or other crop protection chemicals due to more exact application and a lower number of treatments, which implicitly leads to a cleaner, less polluted environment.

Precision agriculture can include intelligent variable-speed irrigation systems, which offer agricultural producers the automatic adjustment of water flow and pressure for each sprinkler or nozzle depending on soil moisture content, crop stage and weather conditions. The more advanced systems are able to do fertigation with intelligent adjustment of the doses of fertilisers dissolved in water taking into account the level of nutrients in the soil and the specific needs of the irrigated crops. These solutions are gaining increasing applications among Moldovan fruits producers and the most important now is to maintain this positive trend and extend the good practices to the entire agricultural sector and to as many processes as possible.

Precision planting allows seeds to be placed at optimal depths and distances, taking into account variations in soil quality and the requirements of the respective crop.

Yield monitoring allows data to be collected during harvest to evaluate variations in the quantities of product in the field, which can be integrated into an intelligent feedback system, thus better understanding how technologies could be adjusted to achieve optimal yield, including by the compensatory introduction of chemical elements extracted with harvest.

An increasing role in precision agriculture is played by drones that can be equipped with cameras and sensors that provide real-time data on crop health, pest infestations and field conditions, which allows monitoring of fields from a distance. Drones are also widely applied to treating plantations with various chemicals. In addition to saving resources and time, their use allows minimising contact with toxic substances for people, thus protecting their health and providing them with better working conditions (Cojocaru, 2024).

Mechanisation, automation and robotisation of agriculture

In context of urbanisation and loss of interest for certain agricultural works from the part of younger generations, the application of equipment that can replace labour or make it easier is becoming a necessity to ensure the economic sustainability of this sector. The depopulation trends registered in

Moldovan rural areas proved that the agricultural competitiveness based on cheap labour has no future. As minimal wages are indexed annually in the most of developed countries and labour is becoming more and more difficult to attract to the agricultural sector, the only way of keeping ensuring that the share of labour costs per unit of production is kept within reasonable limits is to increase the productivity of this factor. Thus, more productive, automated equipment and agricultural robots are gaining ground in modern agriculture.

Modern production technologies for most field crops already involve a high degree of mechanisation. However, the next step is to minimise implication of labour even more by using smart machineries, like driverless tractors or tractors equipped with advanced driver assistance systems. Moreover, various sensors, computer vision cameras in combination with AI algorithms can make the field works extremely efficient. For example, cameras attached to crop sprayers are "trained" to recognise weeds, which allows for the targeted application of herbicides, minimising losses and reducing the negative impact on the environment (Cojocaru, 2024).

A high degree of mechanisation and automation is also found in animal husbandry, especially in the western countries where meat, milk or egg production is very concentrated in order to take advantage of the scale economy. Unfortunately, this sector is less developed in the Republic of Moldova and apparently has less potential to attract private investments and benefit from more consistent government support.

By contrast, horticulture, is a key pillar of Moldovan agriculture, inclusively because this sector is still very dependant on manual labour, which in Moldova is still cheaper than in the most of European countries. However, this advantage is less likely to be sustainable in long term because automation and robotisation of processes can change the landscape in this area too. As we know, harvesting always was one of the most labour-intensive operations, requiring attention and precision. If nowadays the orchard owners in Moldova are happy to use harvesting platforms to increase labour productivity and just few of them use semi-automatic harvesting machines, in western countries these are already a norm. Moreover, it will not be long until the robots will do the harvesting with minimal involvement of humans, thus dismissing the impact of wage figures on total costs and therefore on competitiveness.

Another area requiring special attention is postharvest infrastructure. For example, if in Moldova the packing lines are usually semiautomatic, the larger specialised fruit or vegetable distributors from western Europe use high productive fully automated lines. The accession to EU of the Republic of Moldova will bring the advantage of being able to export considerably faster due to the opening of borders and much faster delivery possibilities. This will bring the possibility for Moldovan exporters to supply directly to retail chains, but for this the country will have to create the necessary packing infrastructure. This resumes the highest possible degree of automation of processes to ensure sufficient versatility for quickly switching to varying standards of different retail chains, usually translated to different labels and quantities in a pack, even if the product is still the same.

Quality and food safety standards and certification

The continuous growth of the global population and the boost of consumerism in 20th century pushed the agriculture to developed both extensively and intensively to satisfy not only the needs for more food, but also for raw materials for various other industries. This has led to deforestation, but also to the reduction of natural habitat areas of many plant and animal species in the most parts of the world. Considering that the intensive technologies often involve the use of synthetic preparations for plant protection or for maintaining animal health, at a certain point not only the reduction of biodiversity, but even the quality of food has become an increasing concern for people. Thus, most developed countries began to impose certain standards for the quality of agricultural products through legislation, especially residues of pesticides, antibiotics or other substances that could pose risks to human health.

An impetus in this regard was the creation in early November 1961 of the Codex Alimentarius Commission within the Food and Agriculture Organisation of the United Nations (FAO). The desire of consumers to have safe food products was also noted by the private sector. In 1997, several retail

chains in Europe, as well as their main suppliers, formed a working group with the task of harmonising their individual standards and procedures and developing a holistic independent certification system for good agricultural practices. This standard is seen as an opportunity to make a difference, promoting safe products while protecting workers and the environment. Being originally conceived for the European farmers, this certification system was initially called EurepGAP (GAP standing for Good Agricultural Practices). However, to reflect that this certification can be applied outside Europe as well, it was renamed as GlobalG.A.P. in September 2007 (EUREPGAP, 2005).
GlobalG.A.P. certification, although a voluntary private standard (being not mandatory by law) has over time become a crucial prerequisite for agricultural producers seeking to access major European retail chains. Thus, Moldovan producers wishing to see their products displayed inside the major European retail chains must implement this certification, which serves as an essential quality assurance mechanism.
Furthermore, in addition to GlobalG.A.P. certification, Western importers over the last decade started more often to require certifications related to employee welfare and corporate social responsibility. While Good Agricultural Practices are predominantly covered by GlobalG.A.P., there is a multitude of certification options to confirm social responsibility compliance. Most often importers and retailers ask for options like GRASP (GLOBALG.A.P. Risk Assessment on Social Practice), Sedex SMETA (Sedex Members Ethical Trade Audit), or Fairtrade certification administered by FLOCERT.

4. Conclusions

The analysis of diverse publications and online sources confirms a strong interrelationship between competitiveness and sustainability. When making their choice, modern consumers consider more and more often not just the inherent quality of products but also the methods by which these products were obtained. As result, the proof that products were obtained from sustainable sources can positively influence market competitiveness.
Climate change directly affects the Republic of Moldova, where drought has become an already common phenomenon. In this context, despite that compensatory measures may offer some temporary relief for agricultural producers confronting various calamities, such reactive approaches are insufficient for securing long-term business sustainability. Instead, the adoption of preventive strategies, despite demanding higher upfront investments, can facilitate a more rapid transition toward climate-smart agriculture. This evolution is essential for ensuring the long-term sustainability of the agricultural sector, provided that all stakeholders, from governmental agencies to producers, input suppliers, and academic researchers, recognise and support these measures.
Adjusting crop assortments and developing cultivars with enhanced resistance to drought, pests, and diseases constitute priority research and investment areas. However, the progress in selecting and breeding varieties adapted to Moldova's changing climatic conditions has been modest. This shortfall in resilient cultivar development also impedes the broader advancement of organic agriculture, which currently remains confined to niche markets. Strategic initiatives aimed at promoting the consumption of healthy, organic products; increasing public understanding of organic practices; encouraging commercial networks; and extending support to producers transitioning to organic methods could collectively stimulate demand and market growth in this domain.
In the context of positive trends regarding the environmental awareness among European consumers and a potential increase in demand for organic products, Moldovan producers can reach more competitive advantage through innovative and eco-friendly agricultural practices. Considering that implementing organic agriculture all at once may be more challenging for agricultural entrepreneurs in the Republic of Moldova, the first recommended step at the initial stage would be to pursue compliance with good agricultural practices and obtain Global GAP certification. The availability of the necessary certification infrastructure, including accredited certification bodies, support organizations that provide guidance and technical assistance, and government subsidies, is an important prerequisite for the greening of Moldovan agriculture, providing clear prospects for the country's products to find their way to the main retail chains in Western Europe.

The conservation agricultural practices, such as no-till farming, are gaining ground in the Republic of Moldova. However, it is too early to conclude that there is already an irreversible trend in this regard and that these practices are being adopted on a massive scale. This field still requires substantial state support, that may result in establishing of the desired climate-smart agricultural framework.

A significant challenge consists in the waning interest in agricultural professions among younger generations. Reversing this trend is imperative to maintain the sector's vitality and sustainability. Enhancing the prestige of agricultural careers through improved working conditions, increased productivity, and better incomes is essential to attract more young people into professions related to farming. A larger application of robotics, artificial intelligence and automation of processes can optimise labour utilisation, boost productivity and protect employees' working conditions and wellbeing. At the same time, improving the living conditions in rural areas is critical, necessitating a coordinated analysis of both agricultural development and rural socio-economic development.

To bolster the competitiveness of Moldovan agricultural products within the European Union market, export-oriented companies should secure certifications that confirm compliance with both good agricultural practices and social standards. Furthermore, in light of the European Union's commitment to achieving climate neutrality by 2050, Moldovan producers should consider adopting net-zero operational strategies, thereby aligning with the practices of the leading European food suppliers.

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