

## AN ECONOMIC PROGNOSTIC STUDY TO EXAMINE THE PRODUCTIVITY OF AGRICULTURAL SMES OF CENTRAL EUROPE DURING THE COVID-19 CRISIS

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**Abstract.** In 2020, the COVID-19 pandemic disturbed the world's Agri-businesses. Several economies are attempting to demonstrate attempts to maintain agribusiness, the agriculture industry, and marketplaces, but distribution networks, access to markets, and affordable farm goods are still vulnerable. The poor and various disempowered populations, particularly those with lower buying power, have been harmed by the COVID-19 outbreak. This study examines the productivity of Central Europe's agricultural SMEs during the COVID-19 pandemic. A predictive model between independent and dependent factors was used to determine and forecast the index or risk for future agricultural SMEs' functioning. The Central European agricultural SMEs' performance indicators were used, such as agricultural output, production of agriculture goods and services, vegetable and horticultural products, fixed capital consumption, agriculture determinants' actual income index, absolute net agriculture business income index, and net agricultural entrepreneurial income. Our results reveal pre and post-COVID-19 agribusiness analyses and their implications for food distribution and sustainability. Our findings also revealed a widespread influence of COVID-19 on Central European areas. The study findings can help agricultural enterprises and policymakers manage the COVID-19 outbreak by providing essential recommendations and consequences.

**Keywords:** agri-businesses, pandemic, agricultural output, SMEs.

**JEL Classification:** E23, E25, E27, O47, O52.

### Introduction

The COVID-19 pandemic has severely impacted worldwide business, and strategies for agriculture productivity, in general, have still been affected, but specific agricultural sectors and economies have been influenced more than other sectors. Significant food shortages have been recorded worldwide, but most governments have taken steps to ensure that agribusiness productivity and distribution networks operate as smoothly and effectively as necessary in the immediate period. However, the pandemic is affecting both short- and long-term food security due to disruptions in international and national trade networks, an imbalance in access to food produced, and logistical

challenges related to labor migrations. The COVID-19 outbreak and accompanying control procedures, including lockdowns, immigration limitations, and borders shut down, were expected to create more disturbances in farming production. The effects of the COVID-19 outbreak on several areas of the agriculture and food chain systems in Central Europe, such as food supply chains, marketing networks, commerce trade, and food and nutrition security, influence various farming sectors, for example, owing to production and demand imbalances. Many Central European farming systems faced significant problems due to major economic, technical, socioeconomic, geographical, and sociological modifications. As a result, the agriculture sector's robustness, or the ability to handle and respond

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to crises and stresses, has been identified as a critical concern. As all characters organize to keep food production going, questions arise about how quickly the food supply will recover from the complicated circumstances caused by the COVID-19 pandemic, how it will interact with the pandemic's different obstacles, and what the social and economic consequences of the disaster would be for agricultural production and food processes. The outbreak of COVID-19 has had a considerable influence on vegetable and fruit output and distribution in Central Europe, particularly regarding worker availability and safety, supply chain operations, and disruption of market performance.

## 1. Literature review

The COVID-19 outbreak disrupted modern agricultural food processing and marketing networks, significantly influencing agricultural productivity and, as a result, food shortages. The COVID-19 outbreak exposed the linkages and interrelations among agriculture, society, and business, as well as the exposure of agricultural production to exogenous pandemic shocks, more than any preceding crisis or outbreak (Stephens et al., 2020). Worker unavailability in food production and processing businesses, increasing unemployment levels, and market instability caused by business limitations are all detrimental influences on the agricultural products market (Leduc & Liu, 2020). However, agriculture is inconsistent worldwide, and agriculture systems have significant variances. While the outbreak has diverse effects on various agricultural sectors and economies, its disrupting nature is clear from when the disease appears. The two most visible immediate effects of COVID-19 on agricultural productivity are decreased revenue and the documented shortages of essential goods (mainly agricultural labour) (Walters et al., 2020).

The outbreak of COVID-19 in a country had a detrimental influence on that nation's agricultural output, although increases in input variables (land, fertilizers, and equipment) could compensate for the loss, resulting in negligible direct consequences. Meanwhile, that "input-offset-productivity" process expanded to neighbouring territories, resulting in considerable indirect and spill over effects. COVID-19 was expected to reduce the agricultural growth rate in 2020, depending on the situation (Zhang et al., 2020). The outbreak experience reminded us that state limitations imposed during significant disasters or crises and shifting consumer behaviour could produce market instability with significant implications for agriculture productivity (Hobbs, 2020). Fear consumption and food storage – not just by households but also through certain authorities – has put significant strain on food output and delivery networks from the beginning of the COVID pandemic. Traditional distribution networks struggled to meet the vital need for some goods and services, whereas other goods saw a significant reduction in both sales and pricing (Almeida & de Souza, 2020). Due to COVID-19, agriculture's contribution to income and

work opportunities has decreased, and more residents are engaged in off-farm jobs. Domestic agriculture production has become more specialized, and its demand for betterment resources has grown (Michler, 2020).

The COVID-19 outbreak restricted the continuous labour movement; the food production labour market was reduced by around 7% in 2020, mainly compared to the earlier period. The national shutdown caused crop damage, leading to a shortage of cultivation and/or crop formation. Consequently, the Jordanian agricultural participation in the gross domestic product at current market prices was reduced by 1.4%, the growth rate at basic price levels was reduced by 1.6%, and the worth of total exported agricultural products was reduced by 1.6%. The Jordanian authorities attempted to improve agriculture output and food availability during the COVID-19 outbreak by issuing agriculture regulations and efforts to reduce the impacts of the COVID-19 outbreak on the agriculture industry (Tarawneh, 2021). Closing countries' borders was a tactic employed in several countries to limit pandemic risk, but it resulted in constraints on agriculture supplies (e.g., seeds, herbicides, and fertilizers) and agricultural labour, as harvesting depended on migrant labour (Laborde et al., 2020). Whereas agricultural production in advanced countries is substantially automated, workers' products (fruits and vegetables) require considerable quantities of human labour and are thus more subject to the impacts of COVID-19. The outbreak has renewed debate about the critical role migrant workers play in today's agricultural food networks while pointing out that these workers are among the most susceptible populations to communicable diseases, with little availability of medical care (Liem et al., 2020).

Agricultural production land appears to be a reasonable investment in an increasingly volatile economic market (Sents, 2021). Because of the unpredictability produced by COVID-19, the chance to acquire further agricultural land continues to grow. The outbreak's agricultural and animal output uncertainties reinforce the almost-low farmland values. To effectively maintain farmland usage at different organizational and regional levels, it is critical to develop a trustworthy and efficacious framework for planning and predicting the future identifiers that characterize the agricultural land resources government and their administration's performance from multiple perspectives (Rasskazova & Sinitis, 2019). Considering the surface of the globe's inhabitants is forecast to exceed 10 billion by 2050, there is no avoiding the truth that global food production must expand. Although additional farmland has formerly been seen to be the apparent response to this challenge, a more significant emphasis on urban agribusiness and worries about the repercussions of invading the environment may prompt a rethinking of how we utilize farmland (Gossett, 2021).

Farming products, food production, and transportation should be seen as critical throughout the disaster for foodstuff to circulate sufficiently from farmers to consumers (Laborde et al., 2020). Nations' lockdowns and border

closures significantly influence farm owners' availability of inputs such as seedlings, fertilizers, herbicides, and pesticides (Galanakis, 2020). There is a growing need to support farm owners all over the world to maintain food supplies. Another measure for maintaining a consistent supply of agricultural goods to the marketplace during the COVID-19 outbreak is to support smallholder farming output by increasing e-commerce. The new approach also includes using information and communications technologies (ICT) in farming, primarily for marketing communications. Social media networks bridge the gap between food processors and prospective customers (Darnhofer, 2020). By standardizing agri-production processes, SMEs can reduce the uncertainties associated with their reliance on migrant temporary employees. It is evident that robotics necessitates a significant initial investment, and certain professions (such as fruits and vegetable processing) are more problematic to organize than others. On the other hand, drones, robotic vehicles, planting robotics, and automated farm machinery suggest a significant decrease in dependence on migrant workers. Farming is projected to gain prominence in emerging economies as a subject of learning and profession (Sihlobo, 2021). Decreasing agricultural and human resources owing to technological and mechanical technology innovation is a global development, leading to a continuous decrease in the number of employees engaging in this agriculture sector. Although substantial advances in the Agri-sector, certain operations, such as particular harvesting products (including different vegetables and fruits), still need a sizeable manual workforce (Garnett et al., 2020). Farming robotics are mainly used to assist producers in overcoming workforce constraints in regular activities, including weeding and harvesting (Garnett et al., 2020). An outbreak such as COVID-19 appears to significantly stimulate the portion of robotics farming concentrated on harvesting unique vegetables in ordinary processes, which are often carried out by migrant labour. This transition will not be rapid and inexpensive; however, one advantage may be that farming trades advances in artificial intelligence or innovation with other industries (Torrero, 2020).

Remote businesses have a lower quality of operational focus during the pandemic. As indicated by the continual changes in farm output, government assistance makes limited attempts to foster diversification and market concentration of agriculture output. Investment in intangible resources is the most productive way to help the agricultural economy (Shabanov et al., 2021). Partnership and coordination between firms are uncommon, with single-owner agribusiness being the more typical organizational type in the agricultural industry. Goods' price levels changed somewhat due to manufacturers' pricing policies being consistent and dependent on economic circumstances. The findings have operational importance since they consider the recognized beneficial means of governmental assistance for agriculture producers in boosting the diversification approach of agricultural goods (Riabchyk et al., 2021). The shutdown of restaurants, hostels, catering

services, and clubs significantly decreased revenues and profits for these goods (Commodity trade), while some farmers ruined unsold products due to difficulty reaching marketplaces. For example, wine purchases in European Mediterranean regions have been reduced by 50%, placing grape producers' revenue at risk (Hobbs, 2020; Loizou et al., 2019; Yilmaz et al., 2020). Numerous "expensive" perishable agricultural products, such as fresh roses, suffered even greater revenue damage. Farmers experience significant levels of income unpredictability under such circumstances. Likewise, the fall in consumer buying capacity – one of the long-term consequences of every crisis or tragedy – is projected to lower farmers' revenue. In addition, the reduction in agricultural revenue causes farmers (mostly small-scale growers) to cut agricultural security and cattle healthcare costs, endangering the efficiency and volume of output (Béné, 2020; Pacheco et al., 2018). The e-commerce model has steadily been used in agricultural research and technological productivity, which has played a significant role in agricultural economic development and productivity improvement. Scientific knowledge and engineering are the primary means of achieving continuous and steady agricultural growth. Agriculture production elements drive the agriculture economy's expansion. The rise in input is attributed in part to increased agricultural resource production. Investments in agricultural research and technology and e-commerce can help boost agriculture growth in the economy (Wang & Huang, 2018).

Agriculture is a business that produces foodstuffs for the inhabitants and is a raw material required in the international marketplace. It plays an essential role not just in the agribusiness system but also in overall economic growth. Agriculture is the most significant market in terms of material output. Agriculture supplies food for the nation, while business generates specific raw resources (Tleuberdiyeva et al., 2021; Kouakou Kouakou, 2020). There is a favorable and robust association between agribusiness and short and long-term productivity expansion. During COVID-19, agricultural crop cultivation has had an adverse influence on GDP. The government is encouraging the production of agricultural goods in order to generate more significant value-added (Warr & Suphannachart, 2021). Increased agricultural production can boost profits and the availability of financing, resulting in an improvement of the capital-intensive industrial sectors. The rate of long-term economic growth was influenced by the level of agriculture business integration (Bustos et al., 2020).

Before the outbreak, the key elements contributing to the livestock sector's upsurge has the expanded demand for meat, cattle, poultry, and seafood. COVID-19 variations have been found in foodstuffs, particularly livestock products, in China. As a result, there would be a growing necessity to maintain food quality and cleanliness throughout the distribution chain (Hu et al., 2021). States must sustain long-term efforts to conserve ecological sources and environments, as well as the profitability of

aquaculture, in reaction to the fishery sector. Economic, equitable, and environmental factors converge to comparable recommended practices: boosting the revenues of those who require it more instead of financing inputs or fishing activity and assuring that evidence-based policies are maintained and executed (Susilastuti, 2018; Lakner et al., 2018). The necessity for all stakeholders to mobilize quickly to help the small-scale fishing industry was highlighted again. Short-term actions must be quick and concentrated on the most affected people. A cross-sectoral intervention will be required in the long run to improve the capability and sustainability of small-scale aquaculture and coastline fishing populations (Bennett et al., 2020). Throughout the COVID-19 outbreak, chemical resources such as fertilizers and insecticides were secure. It is necessary to secure the future chemical delivery chain's stability and dependability. Chemicals will become more accessible and economical to farmers as the distribution network is diversified. A worldwide improvement in ecological requirements for chemical production is also required to assure food quality and safety. Substitute technologies that contribute to a decrease in agricultural chemicals may open up additional prospects for agricultural robotics. Fertilizer rates are expected to stay constant after the COVID-19 period. There are not many new phosphate factories being installed. As a result, as the need grows, so will the price. Supplies and consumption determine future fertilizer costs. The drop in worldwide energy costs caused by COVID-19 also resulted in a drop in nitrogen (N) pricing. Power price cuts are anticipated to boost N prices (Gullickson, 2021).

Yang et al. (2020) gives three recommendations to improve the agriculture economy's stable and fast economic expansion: boost agricultural permanent capital contributions and encourage investors from all business areas to invest in agricultural output. Improve agricultural workforce efficiency and people management education programs; restructure the corporate framework and promote modernized agricultural production. Increased agricultural production might boost total economic expansion, lower the market imbalance, and enhance average earnings and federal profits. The farming trade and wage-earning individuals appear to be the primary stakeholders. Government strategies that encourage the rise of agricultural production may prove to be highly successful in improving economic performance and reducing poverty (Amoussouga Gero & Egbendewe, 2020). Agricultural contributions and output must be produced domestically, foreign exchange must always be managed to make it more beneficial, dishonesty in the agricultural section must be successfully inspected, and government distribution to the agricultural section must be enhanced. In contrast, being supervised ensures prudence in its use, and ultimately, the current regime must promote public partnerships in agricultural production to obtain the desired outcomes (Inusa et al., 2018). Furthermore, the outbreak might adversely influence agricultural and

food production. Social distancing policies impact the performance of agricultural enlargement, particularly in European countries. Ultimately, outbreak preventive efforts combined with economic instability may result in innovation project inefficiencies, cost increases, and other interruptions (Cassidy & Snyder, 2021).

## 2. Objective of the research

The COVID-19 crisis had several severe impacts on the global economy and individuals and detrimental effects on the labour market. COVID-19 negatively influenced the profitability of the farming business, which was highly vulnerable owing to agricultural production security considerations. The crisis has had significant economic consequences. The agricultural and food sectors experienced substantial supply chain disruptions in 2020. Processing of various agricultural foods was lowered owing to a lack of a temporary workforce, obtain limitations to extreme agricultural products, and the inability to market goods. Consumer demand was impacted by unemployment and income losses connected with the countermeasures, as well as decreased high-priced products in great demand, a change in consumer needs away from food availability services, and a reduction in bioenergy consumption. The distribution network interruptions were noticed in several economies because of staff infection in processing enterprises, the implementation of distance and hygienic regulations, and transportation and logistical challenges. These effects have been felt broadly across Europe. So, this study focuses on the impact of the COVID-19 outbreak on agriculture SMEs in Central Europe.

## 3. Data and methodology

In this study, Agricultural SMEs from Central Europe were chosen, comprising significant areas such as agriculture, forestry, and fisheries. This study utilized analytical methods based on the secondary data from Eurostat on central European agricultural SMEs. The study focused on agricultural SMEs' performance in Central Europe, including Austria, Czechia, Germany, Hungary, Poland, Slovakia, and Switzerland, and the data were gathered from 2011 to 2021. We also evaluated agricultural SMEs before and during the COVID-19 crisis and forecasted the productivity of SMEs and the study's prognosis was calculated till 2025. The prime purpose of the findings was to forecast the performance of agricultural SMEs located in Central Europe economies during and after the outbreak in terms of agricultural input, output, and income. An empirical analysis was employed to capture data for forecast study to analyse the performance indicators in order to perform the investigation. The keywords used for this study were: COVID-19, Agri-businesses, agricultural output, SMEs, worldwide lockdowns, business disruption, agribusiness, food delivery network, food scarcity, economic depression, climate change, and natural disasters. Google Scholar, Scopus, and other

worldwide and regional information sources were used as the research platforms. We examined the forecast using a prognostic model between independent and dependent factors to determine the index or risk for the functioning of agricultural SMEs in the future. Purposive sampling was analysed to determine the outbreak's impact on central European agricultural SMEs. The prognostic model was chosen mainly because of the separation of the sample units. To estimate the Central European agricultural SMEs' performance indicators such as agricultural output, production of agriculture goods and services, vegetable and horticultural products, fixed capital consumption, agriculture determinants' actual income index, absolute net agriculture business income index, and net agricultural entrepreneurial income was used. An overview of agricultural SMEs is sufficient for a more in-depth understanding of economic activities in central European agricultural SMEs for this study. After gathering all the necessary data, the study's outcomes were displayed in a classified manner using graphical representations.

#### 4. Agricultural SMEs inside analysis

According to research analyses, the outbreak has been regarded as a number of shocks affecting the agriculture sector's consumption and production. These waves have had varying effects on the agriculture SMEs based on the business profile, comparative shortage of supplies, per capita income, and the financial market of Central European countries. The findings imply that the pandemic's influence extends beyond the immediate, short-term consequences.

##### 4.1. Production

The pandemic in Central Europe caused price instability, and farmers faced price decreases in agricultural commodities. Whereas the initial impact of the disaster on pricing was not as severe as expected, prices dropped even more in the following period – the severe workforce constraint, particularly at the start of the recession. Due to mobility limitations and the difficulty of getting adequate supplies and education for farmers, output was disrupted – increased family expenditures, causing households to move demand to non-livestock commodities (Sulistowati et al., 2020). The outbreak also adversely affected agricultural producers because of currency changes in conversion rates. This increased food inflation caused a decline in consumption and lowered the currency value of farmer product prices. The pandemic's impacts on production and commodity prices have exacerbated instability, decreasing agricultural producers' profits and jeopardizing agricultural operations' already unstable economic sustainability (Lazíková et al., 2019; Dašić et al., 2020). As a result, the outbreak has pushed many small farmers to abandon their businesses. Although this is not a recent phenomenon, the outbreak has exacerbated a tendency that has been in place for several decades.

##### 4.2. Processing

Agricultural processors concentrated on sustaining agricultural processing and harvesting while protecting the workforce from disease transmission. The labour movement, transportation, and trading constraints harmed the agriculture sector's success. Workforce shortages impacted the agriculture industry, and agricultural machinery became inactive (Teignier, 2018; Zsarnóczai et al., 2021). Furthermore, social distance measures were implemented, resulting in a significant decline in the percentage of agricultural labourers. Furthermore, importing fertilizers and manufacturing materials hinders product creation and delivery. The majority of agricultural SMEs may continue to operate during the outbreak. Several SMEs indicated that businesses need to invest in increasing their transport capabilities. Agricultural products have become more standardized, ensuring that goods and services satisfy quality and safety standards. High requirements increased corporate expenses and lower profitability, but the conventional agriculture sector suffered from financial restrictions, making it challenging to implement stringent production regulations (Key, 2019; Dagevos & de Lauwere, 2021).

##### 4.3. Domestic demand

In Central European countries, agricultural product consumption declined during the first stage of the pandemic lockdown, although sales were more substantial than in previous years, despite the absence of regular supplies. Consumption of agricultural products has increased at supermarkets across Europe. Experts proposed that customers expand their household food preparation activities to compensate for the reduction in food supplies. While improvements in-home consumption somewhat compensated for the decrease in the food business, the improvements were not significant enough in various countries to substitute for the decreases (David & Grobler, 2019). With the end of the COVID-19 outbreak lockdowns, demands food services have increased. The outbreak has raised public consciousness of healthier eating habits and food safety (Kurdyś-Kujawska et al., 2021). Also, movement constraints prompted people to experiment with online food purchasing for the first time. As a result, online distribution has become a much more critical business strategy. These findings suggest that improved nutrition knowledge will strengthen existing tendencies towards purchasing more healthful products in the short to long term, and those e-commerce outlets would likely develop at a higher speed with digital services (Lehikoinen et al., 2021).

##### 4.4. International trade and Agricultural products movements

The rise in agricultural costs indicated extensive import limitations imposed by European countries and decreased consumption from commercial food producers and food markets. Because COVID-19 interrupted the festivities,

many imported agricultural items went unsold. Food and beverage shops were closed due to the shutdown and social distance initiatives, reducing the consumption of agricultural products (Stanojević et al., 2021; Lanz et al., 2018). In terms of international agricultural commerce in 2020, exports have declined significantly. Imports of agricultural products were reduced mainly due to COVID-19-related economic slowdowns, decreased food business sales, and transportation challenges experienced by many primary agricultural products importing economies in Central Europe. Lower revenues through the food and hospitality sectors significantly contributed to the drop in worldwide agricultural product trading. During the outbreak, a recurring issue in several economies worldwide was the governmental encouragement of the food self-sufficiency concept (Hrybau et al., 2019; Suh & Moss, 2021). Several governments used trading limitations or other measures to replace domestically grown agricultural products in domestic consumption and commercial food production to promote self-sufficiency and reduce dependence on agricultural product imports.

#### 4.5. Government strategies

Governments have developed a number of methods to reduce the effects of COVID-19 on distribution networks and worldwide business in reaction to its effect on the agriculture industry. The European Union’s critical endeavour to assist ease the impact of the shock was to eliminate the agricultural sector products from transportation, labour, and product mobility limitations. The EU initiated the Programme Support Action (PSA) and conducted proactive agricultural purchasing. Several European governments could not appropriately respond to the pandemic’s impacts, demanding the mobilization of coordinated initiatives from various sectors. In some circumstances, this endeavour resulted in the formation or enhancement of public collaborations (Murugesan et al., 2021). However, these precautions have assisted in lessening the influence of the outbreak on the agricultural industry. The sector’s classification as an essential commodity, and its

accompanying exemption from travel limitations, were critical for maintaining production levels. Simultaneously, government assistance and food distribution to needy households are critical for maintaining consumption.

#### 5. Agriculture sector during the COVID-19 pandemic

The immediate effect of COVID-19 on the agriculture industry in Central European nations was studied in this study. The research revealed that COVID-19’s impact on the agriculture sector was complicated, situational, time-dependent, and challenging to generalize. Furthermore, the combination of observations helped us to establish some broad conclusions. COVID-19 directly impacted the agriculture industry, expressing itself in many multiple waves (Figure 1). The first wave was caused by the virus’s transmission in China and everywhere else, resulting in a minor decline in business and worldwide pricing for agricultural products. The second wave was characterized by the closure of food businesses, shops, and educational institutions, resulting in a decline in household consumption in individual countries. The third wave was associated with fear purchasing, which resulted in an unexpectedly sharp increase in demand. The fourth wave was associated with the already saving of preserved commodities stock of households, which caused demand to fall once more. The fifth wave was related to lower average household income, which reduced household consumption of different agricultural products. The sixth wave represents the recovery period’s start, characterized by recovered output and consumption volumes.

The outbreak had a variety of effects on businesses, imports, and exports in different economies. The pandemic shock caused an overstock of agricultural products in most exporting economies, resulting in a severe market price decline in certain situations. The impact of importing Central European countries was mainly connected to the trade networks in which companies participated. Although producers in commercial networks were running at maximum efficiency, farmers in traditional networks struggled to sell their products. The effect of the

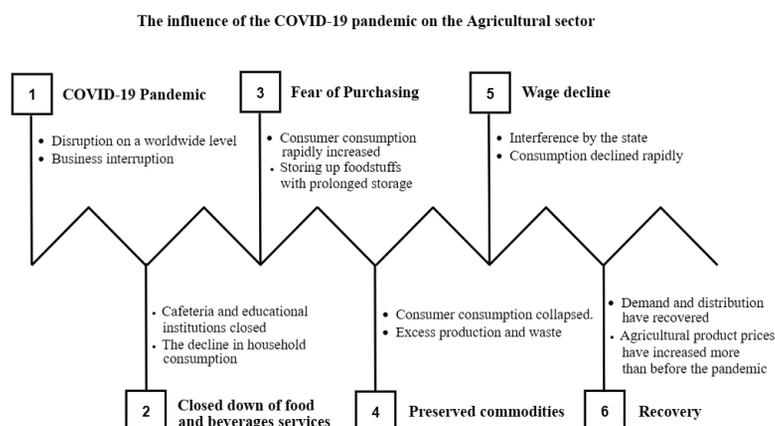


Figure 1. Influence of the COVID-19 pandemic on the agricultural sector

shockwave on output was essentially negligible in certain economies, which can be partly described by the small-scale nature of production processes and the low proportion of agricultural products in kitchen food bowls. While the rebound impact resulted in higher pricing, the outbreak raised production costs, which, combined with the threat of having to comply with increasingly strict environmental standards requirements, prompted several small farm holders to leave the marketplace.

Simultaneously, farmers needed to transfer commodities from food outlets to distribution stores, which required processes, packaging, and transportation changes. Reduced trade participation was worse for small-scale farmers, and conventional processors focused on a few high-value-added items than the chance to increase production in other networks. Plants production in Central European countries was impacted by social distancing restrictions and sporadic accessibility to process materials. One year following the outbreak, the majority of processing businesses had acclimated to the distancing restrictions and were able to resume total operational efficiency. This has not been the case for conventional processors facing financial challenges and difficulty adopting more demanding processing requirements. The impact of the pandemic shock on household consumption differed per country, based on family incomes and the price elasticity of the demand for agricultural products. In general, demand instability was found throughout the waves, with the overall outcome being a decrease in agricultural product sales in lower, medium, and high-income economies. Agricultural products have been added to the catalogue of important perishable products in numerous countries, resulting in a significant rise in the usage of long-shelf-life goods due to their extended end date. As a result, the rise has been measured in terms of quantity rather than price. There was also a change in demand between higher-value agricultural goods to lower-value goods.

States have implemented several initiatives to reduce the pandemic shock's consequences on agriculture. One of the important initiatives was to discourage the food industry, particularly the agriculture segment, from transportation, worker, and commodities transportation limitations. Other reaction efforts included activating measures such as help for domestic preservation, marketing development responsibility programmes, food purchase and delivery, and consumer marketing programmes by various commercial and public sector groups. Many research experts acknowledged that the outbreak is likely to strengthen the agricultural sector's long-term structural restructuring processes. As a result, we anticipate that more farmers will leave the agriculture industry in the medium to long term. Business combinations and restructurings that increase intensity are also expected. Furthermore, increasing consumer knowledge of healthier foods, expanded use of digital advertising platforms, promotion of the principle of food self-reliance, and development of multi-stakeholder collaborations are many other probable adaptation tactics that will probably develop in the future.

## 6. Results and discussion

### 6.1. Agricultural output

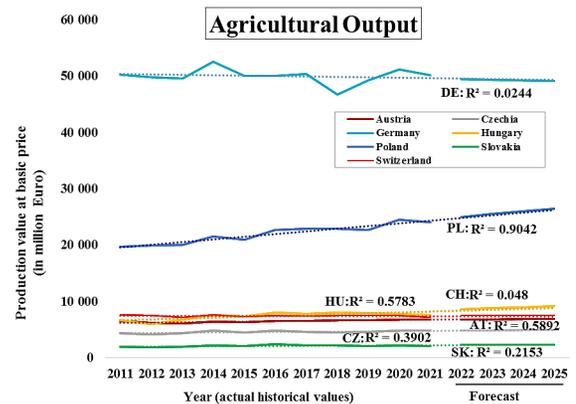


Figure 2. Economic prognostic study of Central European agricultural SMEs using agricultural output (source: own processing)

Figure 2 depicts the Central European agricultural SMEs, encompassing agriculture, forestry, and fisheries, in Central European nations from 2011 to 2021, with projections through 2025. The number of Central European agricultural SMEs climbed significantly from 2011 to 2019 but fell quickly in 2020. Except for Germany and Poland, there was no significant change in agricultural output before the outbreak (2011 to 2019) for Central European agricultural SMEs; during the COVID-19 crisis, there was a slightly declining trend in agricultural output in 2020 due to the COVID-19-enforced lockdown. In 2020, the total agricultural output in Germany and Poland was 51,630 and 24,412 million euros, respectively. While, in 2021, total agricultural output in Germany and Poland fell. However, agricultural output for Czechia, Slovakia, and Switzerland remained the same during the pre-Covid-19 crisis and the pandemic; in contrast, the agricultural output of Austria, Hungary, and Poland decreased during the pandemic. The COVID-19 outbreak strongly influenced the labour marketplace, financial system, agricultural enterprises, and the global food delivery network, generating massive economic disruptions, particularly for agricultural SMEs. It is predicted that by 2025, agricultural output will be increased for Austria, Czechia, Hungary, Poland, Slovakia, and Switzerland, except for Germany.

### 6.2. Agricultural goods output

Agriculture goods are mostly average food and animals produced by farmers on farms. Grain, dairy, cattle, and other agricultural goods produced in Central Europe are utilized by people worldwide. Numerous agricultural goods are also employed as a food source and industrial sector. Participation in agricultural goods output provides tangible advantages for agricultural SMEs. Contributions to agricultural goods outputs that benefit agricultural SMEs contribute to a healthier workplace

atmosphere, optimize earnings, and incorporate a commitment to long-term sustainability. Beginning of 2020, while supply-side reactions to COVID-19 were delayed, agricultural goods declined in the short run due to a lack of agricultural goods supply. In the pre-pandemic period (2011 to 2019), agricultural goods output in all agriculture SMEs of Central Europe remained stable except in Germany, as shown in Figure 3. While till 2021, the agricultural goods output of Germany, Hungary, and Poland declined during the pandemic. It is predicted that Germany’s agricultural output will fall, whereas Austria, Czechia, Hungary, Poland, Slovakia, and Switzerland will increase their agricultural output over time until 2025.

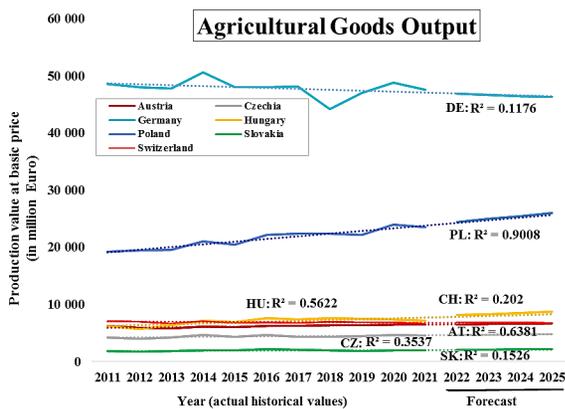


Figure 3. Economic prognostic study of Central European agricultural SMEs using agricultural goods output (source: own processing)

### 6.3. Agricultural services output

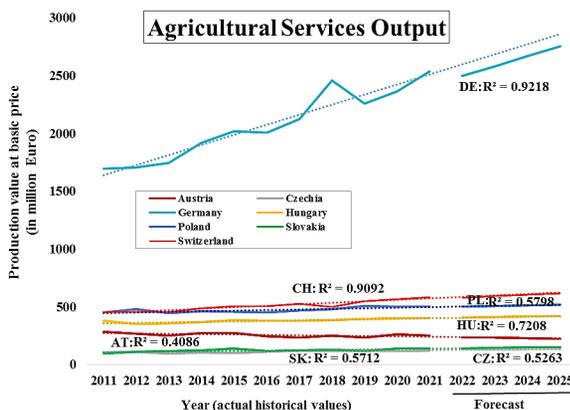


Figure 4. Economic prognostic study of Central European agricultural SMEs using agricultural services output (source: own processing)

Agricultural services are required to expand the agriculture sector by providing information, consultancy, equipment, and supplies to the agricultural industry. Crop cultivation and harvesting with agricultural machinery increase crop productivity, quantity, and quality. The agricultural services output of Central European agricultural

SMEs was evaluated from 2011 to 2025, as shown in Figure 4. The agricultural services output of Austria, Czechia, Hungary, Poland, Slovakia, and Switzerland rose steadily from 2011 to 2019, whereas Germany had a considerable decline in the service output in 2020 and 2021 compared to the other countries. During COVID-19, service production was lower due to lower demand and a breakdown in food supplies in central Europe. During the pandemic, most of the Central European agricultural SMEs were forced to seal their operations owing to lockdown and sanitation restrictions, resulting in a fall in agricultural productivity and negatively impacting the Central European economy’s GDP development. Agricultural services output had a significant influence on agricultural productivity.

### 6.4. Vegetables and horticultural products

Central European countries have historically been significant exporters of horticulture products. This country’s agroecological conditions are favourable for outdoor and undercover agriculture. On large-scale farms, Central-European economies generated a significant portion of the vegetables and fruit products. These items were sent to the wholesaler market and the production sector. On the other hand, smaller farms are produced for their use or in local markets. The domestic horticulture trade was impacted as well by COVID-19 in 2020. Figure 5 depicts the response of vegetables and horticultural products in Central European agricultural SMEs before and throughout the pandemic. The productivity of vegetables and horticultural items in Germany, Poland, Hungary, and Switzerland increased modestly and then decreased slightly from 2011 to 2020, with both nations’ growth slowing in 2021. Austria, Czechia, and Slovakia exhibited gradual growth in vegetables and horticultural products from 2011 to the present. After COVID-19, till 2025, vegetables and horticultural products might fall in Germany and increase in Poland.

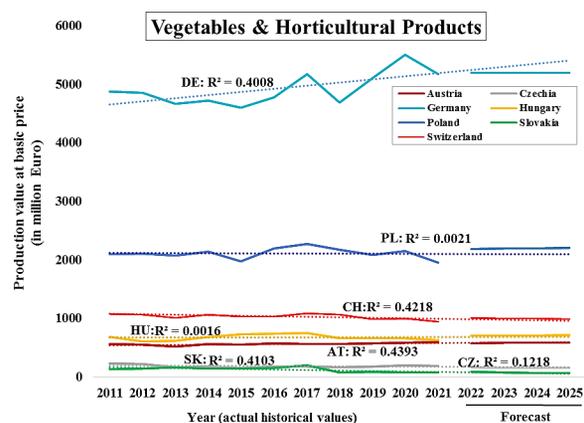


Figure 5. Economic prognostic study of Central European agricultural SMEs using vegetables and horticultural products (source: own processing)

### 6.5. Fixed capital consumption

Fixed Capital Consumption (FCC) is a depreciation charge deducted from the gross income of producing agricultural SMEs, representing the reduction in the value of fixed capital used. Fixed assets lose value after being bought for use in agricultural output because of mark-up, market value fluctuations, and ultimately market unsustainability. As a result, FCC shows settlement for an enterprise's loss of fixed asset value. Figure 6 depicts FCC in Central European agricultural SMEs before and throughout the COVID-19 crisis. The German FCC decreased in value by 8,960 million euros in 2011 but increased somewhat constantly from 2012 to 2020; the FCC again decreased rapidly in 2021 by roughly 9,247 million euros, which was about 9,402 million euros in 2018. Compared to Germany and other chosen Central European countries, the FCC was determined to be the same from 2011 to 2021, and the consumption will be the same until 2025.

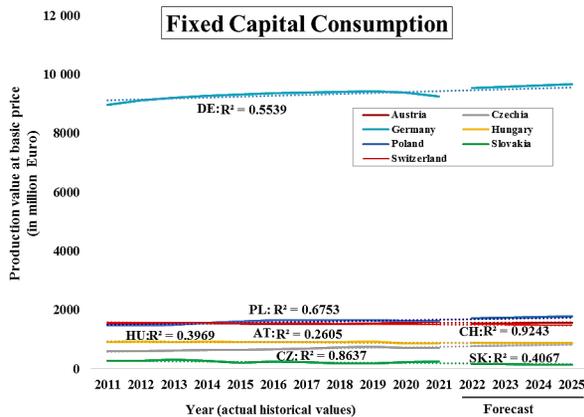


Figure 6. Economic prognostic study of Central European agricultural SMEs using fixed capital consumption (source: own processing)

### 6.6. Index of real income of factors

The real income index of agriculture parameters in Central European agriculture SMEs is used to evaluate economic

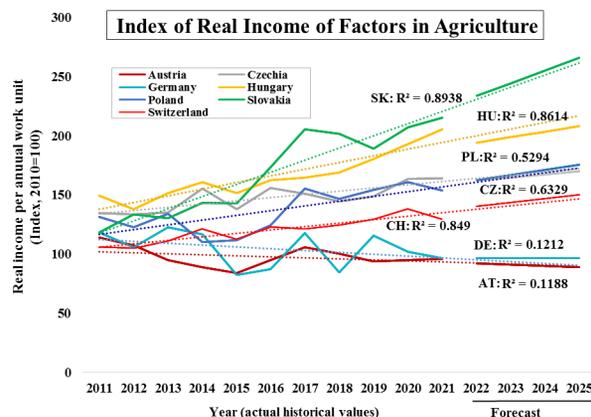


Figure 7. Economic prognostic study of Central European agricultural SMEs using the index of real income of factors in agricultural (source: own processing)

crisis in agriculture businesses and to estimate the difference between gross domestic product and gross domestic income. It is generally the significant difference between the overall price of farming products and services provided and the net profit of farming in Central European countries. This real income index of factors supports understanding the quantity of agricultural income and the country's living standard. In agriculture, the “real income of factors” refers to the reverts received by the three operational parameters: farmland, which yields rents; equity, which generates profits; and labour, which is compensated by wages or salary. Figure 7 depicts the absolute income index of agricultural factors in Central European SMEs throughout COVID-19, with projections through 2025. The actual income index of farming components in Slovakia, Hungary, Poland, and Switzerland was 118, 149, 131, and 106 in 2011, using 2010 as the base year. Slovakia gradually increased its index to 205 in 2017 and fluctuated before increasing again until 2021, while Hungary's index also increased rapidly to around 205 in 2021. However, the index of the remaining Central European countries, including the Czech Republic, Poland, Austria, Germany, and Switzerland, suggested a factor in actual revenue decrease in agriculture in 2021. It is predicted that by 2025, except Hungary, all the Central European counties subjected to this study might increase their real income index of agriculture.

### 6.7. Index of real net agricultural entrepreneurial income

The real net agricultural entrepreneurial income index measures the actual net income generated per year work cycle at the constant price of agribusiness. Subtracting intermediate utilization, devaluation, and other processing taxation from the price of agribusiness production at basic price levels, trying to add the price of many other output tax incentives, depreciating this net price with the underlying market prices of gross national product at market rates, and trying to divide by the total volume farm labour yields the net additional value at current costs. Figure 8 depicts the actual net agriculture business revenue index in Central European agricultural SMEs throughout the pre-Covid-19 and COVID-19 periods from 2011 to 2021, with projections through 2025. The value of the actual net agriculture business revenue index in the Czech Republic was about 229 in 2011, but it has fluctuated dramatically over the years, falling to around 159 in 2018 and then swiftly increasing to approximately 207 in 2021. The remaining central European countries, including Austria, Germany, Hungary, Poland, and Switzerland, had values of 116, 135, 186, 133, and 109 in 2011, respectively, which are very low. Furthermore, these central European countries' values fluctuated wildly from 2012 to 2020, decreasing by around 95, 80, 254, 153, and 132 in 2021. It is predicted that Hungary and the Czech Republic might have fallen from the index of the real net by 2025.

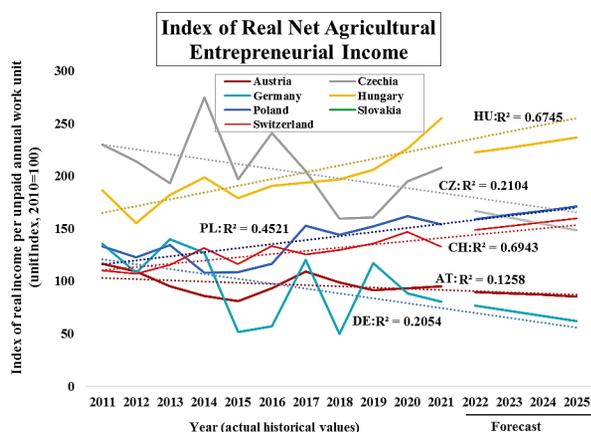


Figure 8. Economic prognostic study of Central European agricultural SMEs using index of real net agricultural entrepreneurial income (source: own processing)

### 6.8. Net entrepreneurial income agriculture

Agricultural entrepreneurial income is defined as “income obtained from agricultural operations carried out for compensation of production elements, acquired after subtracting wages, rent, and interest from total income”. This revenue, therefore, does not represent the farmer’s total income or the revenue available at the agricultural production level because revenue can also be earned from non-agricultural businesses. In other words, agriculture income covers the income generated by operation expansion and revenue generated by non-agricultural business developmental projects. Figure 9 depicts the net entrepreneurial income in agriculture in Central European Agricultural SMEs throughout the circumstances before and during COVID-19 from 2011 to 2021, with projections through 2025. The value of net entrepreneurial income in agriculture in the Czech Republic was approximately 227 in 2011, but it has fluctuated dramatically over the years, falling to around 184 in 2018 and then swiftly increasing to over 218 in 2021. The remaining Central European countries’ entrepreneurial income, which includes Austria, Germany, Hungary, Poland, and Switzerland, were

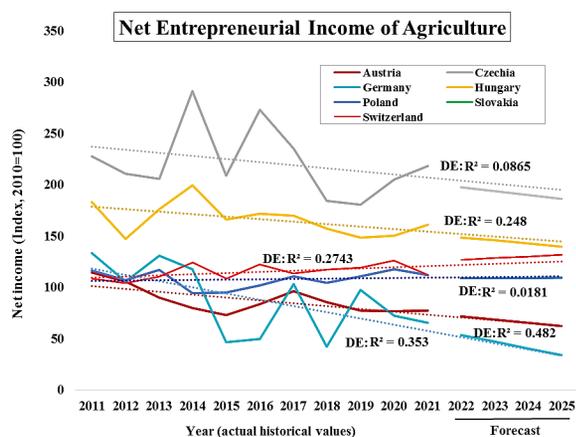


Figure 9. Economic prognostic study of Central European agricultural SMEs using net entrepreneurial income agriculture (source: own processing)

133, 182, 114, 115, and 108 in 2011, respectively, while the income of these countries fluctuated tremendously from 2012 to 2020, decreasing to around 65, 160, 77, 111, and 112 in 2021. It is predicted that by 2025, the Czech Republic and Hungary might face a decline in income.

### Conclusions

This study contributes to the recent COVID-19 investigation based on the productivity of agricultural SMEs. It also presents an insight into the impact, and what actions and policies should be obtained by central European economies to reduce the COVID-19 impact on the agricultural SMEs. The further COVID-19 control restrictions remain in place, the more difficult the process of healing will be in terms of guaranteeing efficient agricultural production, and economic well-being within central European countries. According to our findings, the COVID-19 recession has influenced agricultural producers in the Central European region, and international pandemic remediation initiatives have had considerable, and occasionally unpredicted, influences on farming production through disruptions to farmland workforce markets, business, and supply networks. Furthermore, considering the large intersection between low-income inhabitants and traditional agriculture output in several countries, agriculture has been disrupted. The primary consequences observed were a decline in income, production inefficiencies attributable to barriers to promoting using conventional networks, and obstacles in maintaining agricultural processing techniques related to its limited accessibility of raw materials and workforce. Agricultural producers have evolved to be extra self-efficient in trying to modify, and reduce the number of agricultural land areas, look for quick trading networks, expand productivity, and reconfiguration the approach to the demands of the domestic farmer’s marketplace and access to agricultural collaborative efforts. The recession has imposed substantial constraints on food supply limitations, including reduced food consumption and diversification and increased dependency on household and regional socio-cultural cooperation. COVID-19’s impacts have been observed in several waves influencing the business from the consumption and production aspects. The outbreak has had varying effects on the agri-industry, according to economies’ business dynamics, per capita income, and the financial market. A number of reaction procedures were implemented to reduce the consequences of the shocks, the most notable of which was the exemption of the agricultural sector from restricted mobility. Although the business’s resiliency, our data reveals that the outbreak has prompted continuing fundamental agricultural transformations. The recession has influenced buyer behaviour and consumers’ sense of the value of agriculture: reduced food wastage, a restoration to fresh and domestic foodstuffs, diet adaptability, consumption of fresh foodstuffs, and farmland production of food. There is a considerable prospect for significant agricultural food security disturbances for such communities and long-term

losses in people, ecological, organizational, and economic power. Although agriculture framework robustness capabilities developed, they were not even widely available before. The outbreak most harmed the farming sectors and communities. It is obligated to offset disease outbreak damages in order to sustain other farming framework policy priorities, including achieving food supply or dealing with climate change.

### **Theoretical implications**

This research contributes to the current literature on the productivity of agricultural SMEs in Central Europe during the covid-19 crisis and highlights agricultural SMEs' survivability and recovery methods throughout a long-term disaster and challenges. Essentially, these outcomes are consistent with those of other researchers' efforts on this issue, and it is critical to demonstrate/provide intriguing and current perhaps beneficial themes to focus on during the disaster period.

### **Practical implication**

This research has significant practical implications that focused on the administrators of agricultural SMEs via the measures and modifications that are being implemented at a rapid pace to reduce the consequences of the disaster in the agricultural sector. It also addresses the use of strategies and techniques of producing and supplier relationships, however, as an outcome of shifting consumer preferences. In this regard, the openness of agricultural SMEs to innovations, as well as the research for the expansion of distribution and sales networks, is a significant factor to consider. Training programmes and workshops aimed at agricultural SMEs could assist agricultural executives and workers in adapting to possible future agri-food chain interruptions and developing strategic initiatives to ensure the most optimal utilisation of their resources. They could also invest in processing facilities, which could increase storage capacity, particularly for perishable products. Agricultural SMEs should also educate their representatives on how to manage price volatility and insecurity in agricultural output. Aside from its severe effects on the agri-food network, the outbreak has offered chances for innovation and the advancement of communication systems that may be used to boost agri-food farming and resource distribution networks, as well as to reduce loss and waste of food. It is also meant to serve as a framework for public organizations, particularly regional governments, in implementing policies that will contribute to alleviating the SMEs' negative impacts and overcoming the required adjustments that are being implemented. will remain to be implemented. These regulations are being developed to assist control and minimising the pandemic effects on agricultural SMEs. Healthcare regulations that promote quality and food safety emphasise the relevance of the food supply chain to peoples' health. Worldwide collaboration is required to expedite border processes and

maintain the international supply networks' stability. Food policies must also concentrate on developing agricultural and food networks more durable and adaptable to assist society in transitioning to a climate-neutral society.

### **Limitations of study**

The influence of COVID-19 on agricultural SMEs in general, and its comparisons across central European countries, which does not enable us to generate comparisons with other European countries and regions despite being the primary uniqueness of our research. Future research will concentrate on other European countries.

### **Policies**

The agricultural policy must include steps to ensure the long-term viability of food and agricultural systems, as well as distribution and productivity. Lastly, the agri-food industry may help with employment development, which necessitates the promotion of training through educational programmes that give knowledge and assistance while also encouraging company innovation. Furthermore, policies must guarantee that the economic and tangible aspects of food and nutrition security are addressed in the middle of the COVID-19 pandemic. Without organized, continuous initiatives, there is little uncertainty that possible hazards linked with food shortages during and after COVID-19 would arise, which might in turn escalate to a "disaster inside a disaster". Using publicly accessible data and insights from important persons in the government and private sectors of Central European economies.

### **Recommendation**

The effects of the COVID-19 outbreak on agribusiness may be mitigated by various techniques that assist agricultural producers in overcoming such disasters or disruptions. To begin, states and global organizations must develop efficient disaster management strategies for pandemics and implement resilience-building strategies to improve agriculture's capacity to shift operational mindsets when global instability comes in the future. Policymakers must acknowledge agricultural method distinctions and maintain resource availability (not only financial but also organizational and environmental) for various forms of farming. Furthermore, development programmes should develop and encourage specific targets that further expand "standard" output improvements. On the contrary, re-joining producers and purchasers through regional marketing initiatives can simplify the transfer of agricultural food supplies to buyers during periods of instability, even while offering a resource of income for agricultural farmers. Intellectual technological development can help landowners reduce their dependency on the agricultural workforce while creating better decisions when the environmental situation transforms unexpectedly. These techniques can be utilized to boost farming's ability to handle

shocks or disruptions. Intelligent innovation, for instance, might be a beneficial tool for strengthening the robustness of agricultural systems and promoting the performance of regional branding strategies. Regulations, including the European Commission's Common Farm Strategy, are already in place to handle these problems; yet, data reveal that, while these are admirable goals, they typically struggle to enhance farming's transformability. More initiatives are required to stimulate innovative farming productivity advancements. The pandemic scenario offers several opportunities to consider concerns and provide suggestions for food and agricultural frameworks for sustainable economic development.

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## Conflict of interest

The authors declare that they have no conflicts of interest.

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