

ENHANCING SUSTAINABILITY IN REGIONAL LOW-LAND AND MOUNTAIN AGRICULTURE: AN ANALYSIS OF FARMERS, AND CONSUMERS SIGNIFICANCE

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RESEARCH ARTICLE

Abstract

This study delves into the intricate challenges faced by individual agricultural producers in Romania, exemplified by two national producers. The paper represents a comprehensive analysis that explores the agricultural characteristics of the North-West and South-West Oltenia development regions of Romania, shedding light on their agricultural productivity, especially of two producers of wheat, maize, sunflower, tomatoes, peppers, cucumbers, cabbage. The interplay of geographical diversity, botanical richness, and fauna abundance underscores its ecological significance, especially in the mountain area. Additionally, the analysis delves into individual agricultural enterprises, highlighting challenges faced by producers in Northwest Romania, emphasizing market complexities and environmental concerns. The study underscores the significance of establishing enhanced distribution networks and leveraging local events for effective promotion. Challenges related to market dynamics, environmental sustainability, and competition from large producers form the crux of the analysis.

Keywords: Romanian Agriculture; Romanian Farmers; Regional Dynamics; Consumer Behavior

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INTRODUCTION

In the picturesque landscapes of Northwest Romania, the agricultural sector is marked by the individual endeavors of dedicated producers facing intricate challenges. Among them is Ciotea Adrian Cristian, an agricultural entrepreneur operating as an Individual Enterprise in Bihor County. His specialization in the cultivation of wheat, corn, and sunflower is centered in the plains of Chesa de Bihor, an area known for its fertile soil. However, the idyllic backdrop belies the complexities that Ciotea and his counterparts grapple with, notably the convergence of the Romanian agricultural market with its Hungarian counterpart.

The geographical proximity of production points to the border exposes Ciotea to intensified competition, particularly from producers in the nearby mountainous region, such as Chesa or Dumbrăvița of Bihor. This proximity not only amplifies the intricacies of sales dynamics but also compels producers to navigate challenges in the value chain, often leading to a reduction in added value. Adding to

the complexity is the pervasive issue of erosion, exacerbated by the utilization of disk plows that disrupt soil aggregates, especially in an active wind zone.

Transitioning to the Olt region, another agricultural protagonist emerges in the narrative—Hasnagiu Mihai, a sole proprietor contributing significantly to the production and marketing of Romanian vegetables. The imperative to support the local production and commercialization of vegetables, including tomatoes, peppers, cucumbers, and cabbage, becomes apparent in light of the surplus witnessed in Olt. Operational data from the Ministry of Agriculture and Rural Development (MADR) reveals substantial annual production in tons within Olt County.

Hasnagiu Mihai seeks not only to address the surplus challenge but also to reclaim the local market segment, targeting Romanian consumers. The discourse outlines propositions aligned with the establishment of an enhanced distribution network, particularly benefiting farmers in Olt County. The narrative unfolds against the backdrop of a competitive market, dominated by large local producers and small entrepreneurs, all vying for a significant share.

Hasnagiu Mihai's clientele, ranging from local fairs to consistent buyers at different levels, emphasizes the importance of short supply chains and direct engagement with consumers.

In the subsequent sections, the study takes a scientific analysis and solutions for agricultural producers from Romania, especially for the studied farmers, outlining the methods employed for carotenoid quantification using the HPLC-DAD method.

The reason for approaching the importance of carotenoid in vegetables for farming development is that carotenoids offer multiple health benefits. Carotenoid are a class of pigments widely distributed in nature, contributing vibrant colors to various fruits and vegetables. Beyond their role as natural colorants, carotenoids play a crucial role in human nutrition, offering a range of health benefits. Two prominent examples of crops rich in carotenoids are tomatoes and maize, where these compounds contribute not only to visual appeal but also to the nutritional profile of these staple foods.

Some of the health benefits are antioxidant protection, anti-inflammatory effects, etc. The results offer insights into the carotenoid content in tomatoes and maize, emphasizing their nutritional significance. The synthesis of these findings serves as a foundation for understanding the far-reaching implications on economic viability, environmental sustainability, and the strategic positioning of individual agricultural producers in the Northwest Romanian landscape.

MATERIAL AND METHOD

The imperative to support the production and commercialization of Romanian vegetables, encompassing maize, grain, sunflower, tomatoes, peppers, cucumbers, and cabbage, is vital for reclaiming the local market segment, targeting Romanian consumers. The abundance of vegetable stocks in Bihor and Olt, particularly the studied crops, is substantial, as indicated by operational data from the Ministry of Agriculture and Rural Development (MADR), revealing annual production in tons within these two counties. The propositions outlined in this discourse are aligned with the imperative to establish an enhanced distribution network, particularly benefiting select farmers in Bihor and Olt counties.

The North-West region of Romania, constituting 14.3% of the national land area,

exhibits a remarkably consistent distribution of relief, encompassing 28% mountains, 30% hills, and 42% plains and valleys. The region's utilized agricultural land stands at 13.66%. As of 2014, crucial areas for mountainous products comprised 610,850 hectares of pasture and 401,608 hectares of hayfields, significantly fostering the region's livestock sector. The agricultural output in 2018 reached 10,561 million lei, with vegetable production contributing 7,015 million lei, and animal production accounting for 3,523 million lei. The substantial mountain potential in this region is particularly evident in prominent mountain groups like the Apuseni Mountains and the Carpathians of Maramureş and Bucovina, providing conducive conditions for high-quality mountain production. While the natural environment provides a favorable backdrop for mountain agriculture, there are emerging concerns about biodiversity pollution stemming from nitrogen fertilizers, herbicides, and other chemical treatments. This poses contemplative challenges for socio-economic stakeholders in the region. The mountainous area within this development region stands as a significant bastion for the promotion of Romanian mountain products, particularly within the international arena (ADRVN, 2020; ADRVN, 2016; Horticultura Bucureşti; INS, 2019; PODCA, 2012; UEFISCDI, 2017; Covaci Sterpu, 2023).

Ciotea Adrian Cristian, operating as an Individual Enterprise in agricultural production, hails from Northwest Romania, specifically Bihor County, specializing in the cultivation of wheat, corn, and sunflower. His agricultural endeavors are concentrated in the plain area of Chesa de Bihor, where he faces competition from producers in the nearby mountainous region, such as those in Dumbrăviţa de Bihor. The predominant challenge confronting Ciotea Adrian Cristian pertains to the convergence of the Romanian agricultural market with its Hungarian counterpart, exacerbated by the proximity of production points to the border. The intricate sales dynamics pose significant impediments to the value chain of numerous agricultural producers in Western Romania, thereby constraining market reach. Consequently, agricultural producers find themselves compelled to channel a substantial portion of their produce through the wholesale system, resulting in a notable reduction in added value.

Moreover, the region contends with a pervasive issue linked to erosion. The utilization of disk plows, which overturn and disrupt soil aggregates, has intensified erosion within the district implementing a fallow-cereal rotation system, particularly given its location in an active wind zone (Halbac et al., 2015). This dual challenge of market intricacies and environmental concerns compounds the complexities faced by Ciotea Adrian Cristian and his counterparts in sustaining a robust agricultural enterprise. The ensuing analysis delves into the multifaceted dimensions of these challenges, examining their far-reaching implications on the economic viability, environmental sustainability, and strategic positioning of individual agricultural producers in the Northwest Romanian landscape.

The South-West Oltenia development region, configured as a quadrilateral, encompasses 12.25% of the entire national territory. Similar to other regions in Romania, it exhibits a subdivision into mountainous, hilly, plain, and maritime zones. Home to sections of the Mediterranean Carpathians, the region's mountain groups—Retezat-Godeanu, Șureanu-Parâng-Lotrului, and Iezer-Păpușa-Făgăraș—display an extensive diversity of fauna and flora. The intrinsic landscape value, particularly attributed to the mountains, positions the region as one of the most captivating in the country. The vegetation within the region is characterized by a rich variety, encompassing forests and meadows distinctive to mountainous, hilly, plain, and sub-Mediterranean areas, incorporating deciduous, steppe, alpine, coniferous, and shrub ecosystems. The fauna, especially the mountainous species, provides substantial support for optimal utilization in hunting activities. Leveraging the mountain products, notably derived from the hunting fund, elevates the region to a paramount status among areas endowed with European mountainous productive potential (ADRSVO, 2022; Horticultura București; INS, 2019; PODCA, 2012; UEFISCDI, 2017; Covaci Sterpu, 2023).

Hasnagiu Mihai, a distinguished producer of tomatoes, peppers, cucumbers, and cabbage in the Olt region, is the focus of this narrative. Specifically, Hasnagiu Mihai seeks financial access to facilitate the sale of tomatoes, peppers, cucumbers, and cabbage in both Olt and Bucharest.

The current clientele of Hasnagiu Mihai includes two primary categories:

- Participants in local fairs, markets, and agricultural events within the vicinity of Olt County and the city of Bucharest. Notable events include March Activities, May 1 – The celebration of spring, work and joy, the National Day of the People's Port (May 12), National Costume Day Romanian (May 12), Pentecost Fair (June 16), St. Peter and Paul Fair (June 29), St. Mary's Folk Fair (August 12-18), Harvest Festival and Folk Crafts Fair (September 27-29), and the Christmas market (December).

- Consistent buyers at the local/regional/national levels, particularly those engaging with floating markets in Bucharest and aiming to establish additional presentation and sales stands, adhering to the principles of the short supply chain, eliminating intermediaries.

The significance of events in Bucharest and Olt as additional value, particularly during holidays, should be leveraged to disseminate information effectively, not only to the local population but also to visiting individuals. The products currently offered by farmers—vegetables such as tomatoes, peppers, cucumbers, and cabbage—are well-regarded in their respective regions and could be strategically promoted, especially during autumn and winter. The annual production and distribution volume of 15 tons of vegetables could potentially increase by 15% with additional funding for promotional activities. Furthermore, diversification opportunities, such as the introduction of jams, vegetable syrups, etc., could be explored to augment the product portfolio.

The current scenario reveals that Romania imports vegetables nearly twice the quantity produced locally, indicating substantial untapped potential for the featured farmers in capturing a more expansive market share. Noteworthy competitors include large local producers dominating the market, as well as small entrepreneurs from the presented counties, recognized for their substantial vegetable production.

In confronting formidable competition, it becomes imperative for local farmers to convey the significance of consuming small-batch products to consumers, highlighting the importance of sustaining the local market through a concise supply chain. While the products of certain competitors, both domestic and foreign, flood the market at lower prices, it is crucial for consumers to comprehend the

intrinsic value of supporting local farmers who prioritize product quality over mass production.

MATERIAL AND METHOD

The methods were applied in accordance with Research and Consultancy Contract "Development and optimization of the production of probiotic bacteria" of the University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Romania. The research uses the carotenoid quantification through the HPLC-DAD Method for tomatoes and maize from Chesa and Dumbrăvița, two different regions from Bihor – one from lowland and one from mountain zone. Carotenoid extraction procedure has been realized through the steps described in the following. A 2 g sample underwent extraction with a solvent mixture of Methanol/Ethyl Acetate/Petroleum Ether in a volumetric ratio of 1/1/1 (v/v/v). This extraction process involved vortexing for 1 min using the Heidoph Reax top vortex, followed by 15 min sonication in the Elmasonic E 15 H water bath sonicator and centrifugation at 8000 rpm for 10 min in an Eppendorf AG 5804 centrifuge. This sequence was repeated 3-4 times until complete discoloration of the sample, and the extract was collected in a separation funnel, subsequently washed three times with a 15% NaCl solution. The organic phase, initially filtered with anhydrous Na₂SO₄, underwent additional washing with petroleum ether until complete discoloration. The resulting extract was evaporated to dryness using a Heidolph Hei-VAP Expet rotary evaporator under low pressure. Following this, the sample was redissolved in 1 ml of ethyl acetate, filtered through a 0.45 μm nylon filter, and injected into the HPLC system.

Chromatographic conditions used: the Agilent 1200 series HPLC system, equipped with a solvent degasser, quaternary pumps, DAD detector, and an automatic injector from Agilent Technologies, USA, was employed for the determination of carotenoids. Separation of compounds occurred on the EC 250/4.6 Nucleodur 300-5 C-18 ec. column (250 x 4.6mm, 5μm) from Macherey-Nagel, Germany, at a temperature of 250°C. The mobile phases consisted of acetonitrile/water/triethylamine 90/10/0.25 (A) and ethyl acetate/triethylamine 100/0.25 (B), utilizing the following gradient: at min 0, 90% A; at min 10, 50% A. The percentage of solvent A decreased from 50% at min 10 to 10% at min 20. The flow rate was maintained at

1 ml/min, and chromatograms were recorded at a wavelength of λ=450 nm.

Data acquisition and results interpretation were conducted using the Agilent ChemStation software.

Reagents and materials: acetonitrile and ethyl acetate, of HPLC purity, were procured from Merck (Germany), and ultrapure water was obtained through purification with the Direct-Q UV system from Millipore (USA). Lycopene and β-Carotene standards from Sigma-Aldrich (Germany) were employed for the identification and quantification of carotenoids.

Calibration curves: to quantify carotenoids in tomato samples, two calibration curves were constructed by injecting five different concentrations of Lycopene and β-Carotene, respectively. The meticulous use of high-quality reagents and standards, coupled with precise chromatographic conditions, ensures the accuracy and reliability of the carotenoid quantification process. The ensuing calibration curves provide a robust foundation for the accurate determination of carotenoid content in the analyzed samples (figures 1 & 2).

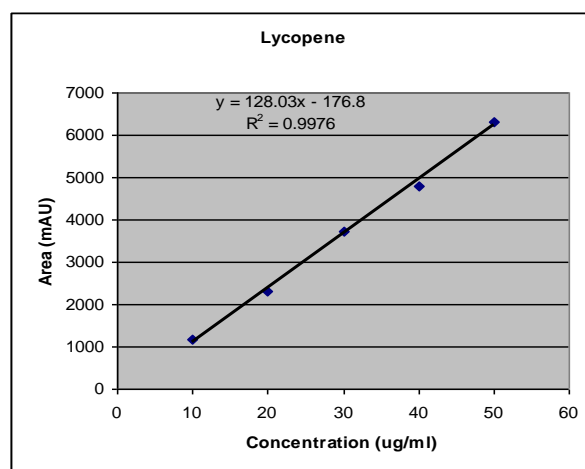


Figure 1. Lycopene concentration for the analyzed agricultural products

The figures and tables of the paper are processed by the authors in accordance with Research and Consultancy Contract "Development and optimization of the production of probiotic bacteria" of the University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Romania.

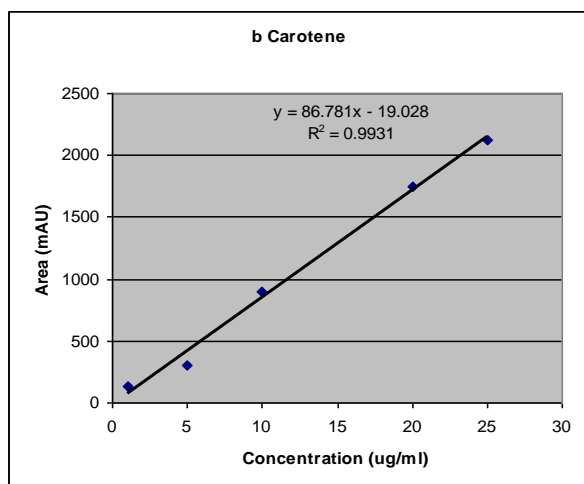


Figure 2. β -Carotene concentration for the analyzed agricultural products

RESULTS AND DISCUSSIONS

The results show that the effects of carotenoids in tomatoes and maize influence the consumers behaviour, meaning that the buyers want most vegetable with more lycopene and β -carotene. Carotenoids, a class of pigments with diverse health benefits, play a crucial role in both tomatoes and maize, contributing not only to their vibrant colors but also to their nutritional value. The primary carotenoids found in these crops include lycopene, β -carotene, zeaxanthin, and lutein, each offering unique advantages.

For tomatoes it was observed that in lycopene, tomatoes are renowned for their high lycopene content, a carotenoid known for its potent antioxidant properties. Lycopene has been associated with a reduced risk of certain cancers, particularly prostate cancer. Additionally, it contributes to skin health by providing protection against UV radiation. Regarding β -Carotene, it can be observed that this is more commonly associated with orange and yellow vegetables, its presence in tomatoes enhances their overall carotenoid profile. β -carotene converts into vitamin A in the body, supporting vision health and bolstering the immune system.

Regarding maize (corn), it can be observed that this is rich in zeaxanthin and lutein, carotenoids known for their role in maintaining eye health. These compounds accumulate in the retina, where they act as natural filters, protecting against harmful high-energy light waves like ultraviolet rays. Similar to tomatoes, maize also contains β -carotene, contributing to its yellow coloration. The conversion of β -carotene to vitamin A in the

body aids in maintaining healthy skin and mucous membranes.

The results for chromatograms at tomatoes show that these are higher in the Dumbrăvița mountain products (13927 mAU) than in the Chesa plain products (13925 mAU), while at maize the situation is opposite Dumbrăvița mountain products contains higher chromatograms (7014 mAU) than Chesa plain products (7005 mAU) (figures 3, panels a-d).

As can be seen in the figures and in the following tables, the results of the identification and quantification of carotenoids in tomato samples from two locations, Dumbravita and Chesa (table 1).

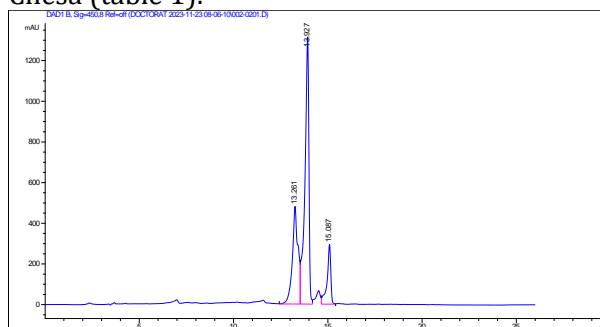


Figure 3a. Chromatograms at Dumbrăvița tomatoes

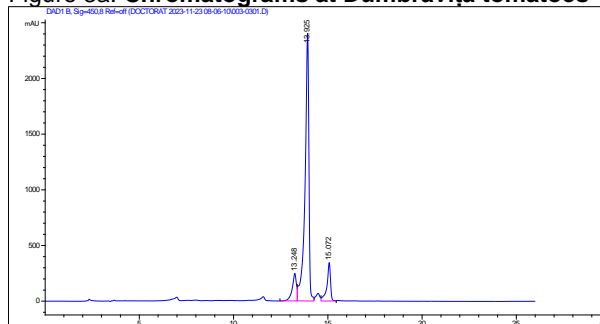


Figure 3b. Chromatograms at Chesa tomatoes

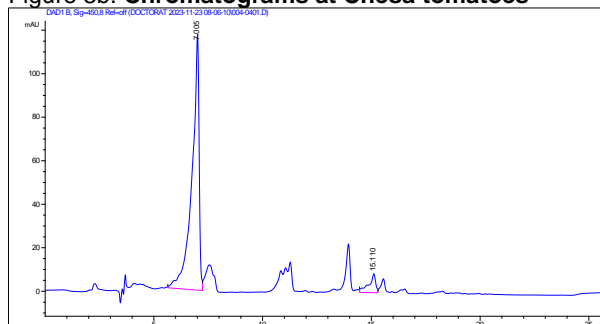


Figure 3c. Chromatograms at Dumbrăvița tomatoes

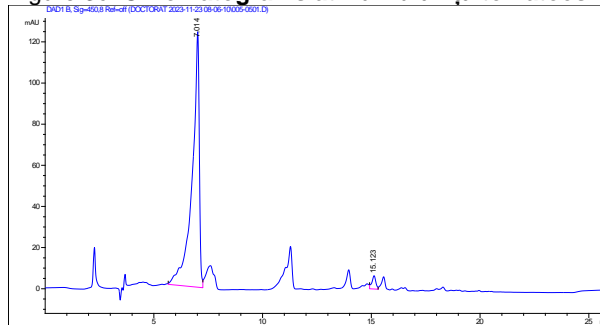


Figure 3d. Chromatograms at Chesa tomatoes

DISCUSSIONS

The analysis reveals the presence of two major carotenoids, Lycopene and β Carotene, with varying concentrations in the respective samples. The total carotenoid content is expressed in milligrams per 100 grams of the tomato sample.

In the table regarding maize (table 2), the analysis extends to carotenoids present samples from Dumbravita and Chesa. The predominant carotenoids identified include α Carotene and β Carotene, with their respective concentrations expressed in milligrams per 100 grams of the maize sample.

Table 1
Identification and quantification of carotenoids in tomato samples, amount expressed in mg/100g sample

Peak	R _t (min)	λ_{\max} (nm)	Compound	Dumbravita	Chesa
1	13.92	448, 474, 508	Lycopene	11.551	14.987
2	15.08	455, 480	β Carotene	2.312	2.640
			Total	13.862	17.627

The total carotenoid content provides an overview of the carotenoid composition in the analyzed maize samples.

Table 1
Identification and quantification of carotenoids in corn samples, amount expressed in mg/100g sample

Peak	R _t (min)	λ_{\max} (nm)	Compound	Dumbravita	Chesa
2	12.37	453, 480	α Carotene	1.558	1.647
3	13.52	455, 480	β Carotene	0.121	0.059
			Total	1.679	1.706

These tables serve as valuable references for understanding the carotenoid composition in tomatoes and maize from different regions, providing insights into the nutritional content of these agricultural products. The variations in carotenoid concentrations highlight the potential impact of geographical factors on the composition of bioactive compounds in crops.

Value Chain Analysis of Tomatoes and Maize in Bihor, Romania

In Bihor, tomato cultivation is characterized by a diverse range of small and medium-sized farms, leveraging the region's favorable climate and soil conditions to produce high-quality tomatoes. Modern agricultural practices, such as greenhouse cultivation and drip irrigation, are employed to optimize yield. Harvesting involves a careful balance of manual and mechanical techniques to minimize damage, followed by meticulous sorting, washing, and packaging to maintain freshness and quality.

The distribution process includes direct supply to local markets in Bihor and neighboring regions, with the involvement of wholesalers for broader distribution within and beyond the region. Additionally, some tomatoes are directed to local processing units for the production of sauces, canned products, or other processed items, while fresh tomatoes find their way into households for use in cooking and salads.

Bihor's maize production encompasses a mix of small, medium, and large-scale farms, benefiting from the region's agro-climatic conditions. Adoption of modern farming practices enhances yield, and the harvesting process combines mechanized and manual methods for efficient corn cob collection. Adequate drying and storage facilities are in place to preserve the quality of maize.

The distribution network involves direct supply to local markets within Bihor and potentially nearby regions, often in collaboration with wholesalers for extended market access. Some maize undergoes processing for products like cornflour or snacks, with ongoing exploration of opportunities for new maize-based products. Distribution channels include local grocery stores and markets, as well as direct engagement with consumers at farmers' markets, emphasizing maize as a staple in local diets.

Value Chain Analysis of Tomatoes and Maize in Ilt, Romania

In Ilt, tomato production is characterized by a mix of small and medium-sized farms, where climate and soil conditions significantly impact the variety and yield of tomatoes. The adoption of sustainable farming practices reflects environmental stewardship, and efficient harvesting techniques ensure the

preservation of quality during transportation. Sorting, washing, and packaging are crucial steps in maintaining freshness.

Distribution channels include direct supply to local markets within Olt and potential expansion to neighboring regions, often facilitated by distributors for wider market access. Some tomatoes are directed to local processing units, encouraging exploration of innovative processing techniques for product differentiation. Distribution extends to local grocery stores and supermarkets, with participation in agricultural events and fairs for direct consumer interaction. The end-users, households, benefit from fresh, locally-sourced tomatoes, with awareness campaigns highlighting their nutritional benefits.

Olt's maize production involves a blend of traditional and modern farming methods, guided by agro-climatic conditions and a commitment to integrated pest management. Harvesting methods, both manual and mechanized, ensure efficiency, while storage facilities maintain maize quality.

Distribution networks encompass direct supply to local markets within Olt and potentially nearby regions, with strategic partnerships with distributors to broaden market reach. Maize's versatility is explored through various processing applications, including food products and industrial uses, paving the way for market diversification. Local grocery stores, markets, and farmers' markets serve as key retail channels, connecting producers directly with consumers. Maize products continue to be dietary staples in local households, and efforts focus on promoting the economic and nutritional benefits of locally-produced maize.

In both Bihor and Olt, a comprehensive approach to the value chain underscores sustainable practices, technological innovation, and direct consumer engagement, fostering the resilience and growth of the tomato and maize sectors.

CONCLUSIONS

The results highlight the importance of tomatoes and maize development, due to the consumers behaviour from West and South-West Oltenia, that prefer more this vegetable than others. It's important to note that the health benefits of carotenoids are often best realized when these foods are consumed as part of a balanced and varied diet. Including a spectrum of colorful fruits and vegetables, such

as tomatoes and maize, ensures a diverse intake of carotenoids, contributing to overall health and well-being.

In conclusion, the North-West region stands as a key player in Romania's agricultural landscape, with a well-distributed relief and considerable potential for mountainous production. However, the region grapples with challenges related to biodiversity pollution, necessitating a careful balance between agricultural practices and environmental sustainability. On the other hand, the South-West Oltenia region emerges as a biodiversity-rich area, particularly in its mountainous zones, contributing substantially to European mountainous productivity. The intricate relationship between diverse landscapes, flora, and fauna positions this region as a vital ecological reservoir. As we scrutinize individual agricultural enterprises in Northwest Romania, the challenges faced by Ciotea Adrian Cristian and Hasnagiu Mihai underscore the complexities of navigating both market dynamics and environmental sustainability. These insights provide a foundation for strategic interventions to ensure the sustainable development of these regions and the prosperity of individual agricultural producers. Additionally, the examination of carotenoids in tomatoes and maize underscores the nutritional significance of these crops, emphasizing the importance of diverse and balanced dietary choices for overall health and well-being.

The challenges faced by Ciotea Adrian Cristian and Hasnagiu Mihai shed light on the multifaceted dimensions impacting agricultural producers in Northwest Romania. The convergence of markets and environmental concerns poses formidable obstacles, emphasizing the need for strategic interventions. Ciotea's battle with intricate sales dynamics and environmental challenges showcases the delicate balance required for economic viability and environmental sustainability. Hasnagiu's endeavor to reclaim the local market for Romanian vegetables highlights the potential for enhanced distribution networks and promotional activities. The call to support local farmers and convey the intrinsic value of small-batch products becomes pivotal in the face of stiff competition. This analysis serves as a foundation for addressing the far-reaching implications on economic viability, environmental sustainability, and the strategic

positioning of individual agricultural producers in the Northwest Romanian landscape.

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