AGORA International Journal of Economical Sciences, http://univagora.ro/jour/index.php/aijes
ISSN 2067-3310, E-ISSN 2067-7669
Vol. 19, No. 2 (2025), pp. 145-153

ECONOMIC EFFICIENCY AND DEVELOPMENT TRENDS OF APPLE PRODUCTION IN THE QUBA–KHACHMAZ ECONOMIC REGION IN AZERBAIJAN

E. JABIYEV

Eltaj Jabiyev
Baku State University, Baku, Azerbaijan
https://orcid.org/0000-0003-1888-1160, E-mail: eltaccabiyev@bsu.edu.az

Abstract: *This study analyzes the economic efficiency and development trends of apple production in the Quba–Khachmaz economic region of Azerbaijan. Using statistical and analytical methods, including the Compound Annual Growth Rate (CAGR), the research evaluates changes in cultivated area, yield, and total production for the period 2020–2030. Findings reveal that although orchard areas have declined by over 20 percent, productivity has increased by more than 25 percent, indicating a shift toward intensive and resource-efficient agricultural practices. The transition to intensive and super-intensive orchard systems enhances production stability through technological innovation, improved irrigation, and sustainable resource use. These results demonstrate that modernization in fruit farming strengthens economic resilience and supports the transformation from extensive to intensive agriculture. The study contributes to the achievement of the UN Sustainable Development Goals (SDGs) by promoting sustainable agricultural growth, resource optimization, and environmentally responsible production models.*

Keywords: *Quba–Khachmaz Economic Region; apple production; economic efficiency; agricultural sustainability; intensive orchards; SDG 2 – zero hunger; SDG 12 – responsible consumption and production*

INTRODUCTION

Agriculture, as one of the fundamental pillars of the national economy, plays a crucial role in ensuring food security, increasing employment, and promoting the socio-economic development of regions. As a result of the state programs implemented to diversify Azerbaijan's non-oil sector, significant structural transformations have taken place in agriculture, particularly in fruit-growing. These changes are evident both in land use patterns and in production technologies. In recent years, traditional farming practices in many of the country's economic regions have gradually been replaced by intensive and super-intensive systems. Under such circumstances, the focus has shifted from the mere expansion of production volume to the efficient management of resources and the enhancement of productivity.

The Quba–Khachmaz economic region has been selected as a key subject of this study because apple production represents one of the main directions of regional specialization, both economically and socially. At the same time, the region stands out for its favorable soil and climatic conditions, agro-technical potential, and productivity indicators. However, in recent years, a decrease in cultivated areas has been observed, which can be explained by the restructuring and intensification of production. This situation raises an important question: how does the reduction of cultivated land affect total output, and what are the economic implications of this process? In recent years, market prices in the fruit sector have shown tendencies either to stagnate or decline, making the sales process unstable and risky for producers. Maintaining economic efficiency under such conditions requires farmers to demonstrate higher levels of performance and management skills (Lakner & Apáti, 2010). The development of post-harvest stages is considered one of the most effective ways to enhance economic efficiency. The adoption of modern processing, grading, packaging, and storage technologies extends

the marketing period, meets consumers' expectations regarding quality and appearance, and ultimately contributes to higher average sales prices (Doluschitz, 2001; Möhring et al., 2007).

If we take a closer look at the European model, it becomes evident that the most widely cultivated fruit tree across Europe is the apple tree, which accounts for approximately 35 percent of all orchard areas, covering around 450 thousand hectares (European Union, 2015). In 2013, the total volume of apple production across the 28 member states of the European Union reached approximately 12 million tons (European Union, 2015). During that period, Poland emerged as the leading apple producer in the EU, with an annual output exceeding 3 million tons, followed by Italy and France. In Romania, the annual volume of apple production was recorded at around 503 thousand tons. However, the main challenge for Romania lies in its low productivity levels. Between 2003 and 2012, apple production in the country declined by about 43 percent (World Apple and Pear Association, 2015). The total area of apple orchards in Romania constitutes roughly 11 percent (51,226 hectares) of all apple-growing land within the European Union. By comparison, although France accounts for only about 8 percent of the total orchard area, its volume of apple production is four times higher than that of Romania (European Union, 2015).

Over the past 24 years, the total area of land planted with apple trees has declined in both the European Union and Romania. In Romania, this reduction has reached approximately 33 percent, while at the EU level, the decrease amounts to around 15 percent. The contraction in orchard areas is primarily attributed to improvements in productivity. Between 1990 and 2013, apple yield in Romania increased by roughly 8 percent, corresponding to an average annual growth rate of about 0.32 percent. During the same period, productivity across the European Union rose by 12 percent, reflecting a general trend toward more efficient and intensive cultivation systems.

Previous research has demonstrated that there is no significant difference in the organic matter content of soils between organic and conventional apple orchards (Gasparatos, D. et al., 2011). The main factors influencing apple production include the use of organic fertilizers, farmers' experience, and the availability of labor resources; together, these components account for approximately 48 percent of total production costs (Herencia, J.F. et al., 2008). Other scholars have identified six key factors affecting the profitability of apple production: yield levels, fruit quality (as reflected in grading results), orchard size, varietal diversity, production costs, and specialization in organic production and/or direct marketing (Stockdale, E.A. et al., 2001)

Due to farmers' limited knowledge and restricted access to appropriate technologies, fertilizers are often applied in excessive quantities (Murphy, K., 2012), leading to adverse environmental consequences. Organic farming systems and small-scale agribusinesses tend to benefit from higher market prices, which makes them economically more efficient (Murphy, K., 2012). However, the organic nature of production does not automatically guarantee its sustainability (Bravin, E. et al., 2015). For agricultural production to be sustainable, it must be profitable, of high quality, environmentally safe, and aligned with principles of social responsibility (Bravin, E. et al., 2015).

In most parts of the world, farmers have shifted from traditional to intensive production systems (Gul, M., 2005). Over the past fifty years, planting density in apple orchards has increased dramatically—from about 40 trees per acre to as many as 3,000 trees in some cases (Reganold, J.P. et al., 2011). Establishing high-density systems requires substantial investment, with the majority of costs associated with the purchase of seedlings. Although growing one's own seedlings can reduce initial expenses, it typically delays the onset of fruit-bearing by one year (Reganold, J.P. et al., 2011). Low-density systems, on the other hand, are considered economically inefficient since they require between five and eight years to reach full productivity (Gul, M., 2005). The choice of planting system varies depending on geographic location, cultivar and varietal diversity, soil type, rootstock selection, and local socio-economic factors (DeJong, T.M., et al 1999). The social aspect of sustainable development has received relatively little attention in the scientific literature; however, recent studies indicate that conceptual understanding in this area has begun to take shape. Although the notion of social stability

is often discussed in the context of social policy, it is increasingly recognized as an essential component in evaluating the social pillar of sustainable development.

The primary aim of this study is to evaluate the economic efficiency of apple production in the Quba–Khachmaz economic region and to identify future development trends in productivity, cultivated area, and production volume up to the year 2030.

In accordance with this aim, the following research objectives have been defined:

- To analyze the dynamics of apple production, cultivated area, and yield indicators in the region for the period 2020–2024;
- To identify the economic and structural factors underlying the reduction of cultivated areas;
- To assess the technological and managerial factors influencing productivity growth;
- To forecast key indicators for the year 2030 based on the Compound Annual Growth Rate (CAGR);
- To propose recommendations for the development prospects of fruit growing in the Quba–Khachmaz economic region based on the findings of the research.

METHODOLOGY

The study employs both statistical and analytical research methods. The main methodological approach is based on the Compound Annual Growth Rate (CAGR) formula, which is used to calculate the average annual growth rates of apple cultivation area, production volume, and yield for the period 2020–2024. This approach enables an objective assessment of the rate of change in key production indicators over time, providing a quantitative foundation for forecasting development trends up to 2030.

The Compound Annual Growth Rate (CAGR) is calculated using the following formula:

$$r = \left(\frac{Y_{end}}{Y_{start}}\right)^{\frac{1}{n}} - 1$$

where:

r – CAGR, the compound annual growth rate (Investopedia, CAGR);

Y_{start} – the initial value of the indicator (e.g., production volume, cultivated area, or yield);

Y_{end} – the final value of the indicator;

n – the number of years in the observed period.

This formula reflects the average annual rate at which a variable grows (or declines) over a given period, assuming the growth occurs at a compounded rate.

In addition, to forecast the dynamics of apple cultivation area, production volume, and yield for the period 2024–2030, the study employs a CAGR-based projection formula adopted by leading international economic and statistical institutions such as the OECD, FAO, and Investopedia. The formula is expressed as follows:

$$Y_{forecast} = Y_{start} \times (1 + \mathrm{r})^{n}$$

where:

$Y_{forecast}$ – the projected value for the target year;

Y_{start} – the base or initial value of the indicator;

r – the CAGR, representing the compound annual growth rate;

n – the duration of the projection period (in years).

This approach allows for estimating future performance trends under the assumption of constant compound growth, providing a reliable analytical framework for medium-term forecasting.

Furthermore, the study employs trend analysis, comparative analysis, graphical visualization techniques (including line and combo chart models), as well as empirical observations to enhance the validity and interpretability of the results.

CONCLUSIONS AND DISCUSSIONS

ECONOMIC EFFICIENCY AND DEVELOPMENT TRENDS OF APPLE PRODUCTION IN THE QUBA–KHACHMAZ ECONOMIC REGION IN AZERBAIJAN

The Quba–Khachmaz economic region is one of the largest and most specialized areas of Azerbaijan in terms of fruit production. Within the region's agricultural sector, apple cultivation holds a distinctive position, playing a vital role both in meeting domestic market demand and in strengthening the country's export potential. At present, the total area of fruit orchards across the region covers several thousand hectares, with apple orchards accounting for the predominant share of this land. This specialization has positioned Quba–Khachmaz as a key contributor to Azerbaijan's fruit-growing industry and as a central hub for high-value agricultural production.

Table 1. *Apple orchards in the fruit-bearing stage (hectares)*

Economic Region and districts	2020	2021	2022	2023	2024
Quba–Khachmaz Economic Region	**21500.3**	**21968.9**	**21317.8**	**18551.0**	**16702.3**
Khachmaz District	4315.1	4364.9	3501.8	2574.6	2278.6
Quba District	13192.7	13196.2	13308.9	11324.2	9472.7
Qusar District	3533.4	3915.1	3983.2	4123.1	4421.7
Siyazan District	28.0	27.5	28.0	28.0	28.0
Shabran District	431.1	465.2	495.9	501.1	501.3

Source: State Statistical Committee of the Republic of Azerbaijan, 2024

As shown in Table 1, the total area of apple orchards in the fruit-bearing stage within the Quba–Khachmaz economic region is presented by year. An examination of the overall dynamics of apple orchards across the Quba–Khachmaz region reveals the following trend.

Table 2. *Overall Dynamics (Quba–Khachmaz Economic Region)*

Year	Total area (ha)	Annual change (ha)	Annual change (%)
2020	21,500.3	-	-
2021	21,968.9	+468.6	+2.2 %
2022	21,317.8	−651.1	−3.0 %
2023	18,551.0	−2,766.8	−13.0 %
2024	16,702.3	−1,848.7	−10.0 %

As the overall dynamics indicate, the total area of fruit-bearing apple orchards in the Quba–Khachmaz economic region decreased by approximately 22 percent during the period 2020–2024. According to the results of surveys conducted among local residents of the economic region, this decline is primarily attributed to the aging of existing orchards and the fact that newly planted trees have not yet reached the fruit-bearing stage. These factors have notably intensified the downward trend, particularly after 2022.

Table 3. *Apple production, tons*

Economic Region and districts	2020	2021	2022	2023	2024
Quba–Khachmaz Economic Region	**214326.8**	**218528.0**	**225618.7**	**214048.3**	**206882.3**
Khachmaz District	53381.9	52355.5	54648.4	45973.2	40135.1
Quba District	125328.9	129204.4	132134.6	124952.7	112920.1
Qusar District	32916.4	34764.2	35290.4	39965.2	50774.6
Siyazan District	198.0	203.0	203.2	199.0	191.0
Shabran District	2501.6	2000.9	3342.1	2958.2	2861.4

Source: State Statistical Committee of the Republic of Azerbaijan, 2024

Table 4. *Overall dynamics of apple production in the Quba–Khachmaz economic region*

Year	Total production (tons)	Annual change (tons)	Annual change (%)
2020	214,326.8	-	-
2021	218,528.0	+4,201.2	+2.0 %
2022	225,618.7	+7,090.7	+3.2 %
2023	214,048.3	−11,570.4	−5.1 %
2024	206,882.3	−7,166.0	−3.3 %

As observed from the overall production dynamics, total apple output in the Quba–Khachmaz economic region decreased by approximately 3.5 percent over the five-year period. Although a growth trend was evident between 2020 and 2022, production began to decline from 2023 onward. This decline during 2023–2024 can be attributed to several factors, including unfavorable weather conditions, aging orchards, the delayed fruit-bearing stage of newly planted trees, and—as clearly shown in Tables 1 and 2—a sharp reduction in orchard area. The regional dynamics can be summarized as follows:

- Quba District continues to account for over 55 percent of total production; however, its output declined by nearly 10 percent between 2020 and 2024.
- Khachmaz District experienced a sharp decrease of around 25 percent, which parallels the reduction in orchard area noted in earlier tables.
- Qusar District demonstrated rapid growth (+54%), primarily due to the introduction of new intensive orchards reaching the fruit-bearing stage.
- Siyazan and Shabran Districts showed only minor changes, though their combined share in total production remains relatively small—about 1.5 percent.

Table 5. *Apple yield in the Quba–Khachmaz economic region (centners per hectare)*

Economic Region and disttricts	2020	2021	2022	2023	2024
Economic Region and disttricts	**98.6**	**99.5**	**105.8**	**115.4**	**123.9**
Quba–Khachmaz Economic Region	123.7	119.9	156.1	178.6	176.1
Khachmaz District	95.0	97.9	99.3	110.3	119.2
Quba District	86.8	88.8	88.6	96.9	114.8
Qusar District	70.7	73.8	72.6	71.1	68.2
Siyazan District	58.0	43.0	67.4	59.0	57.1

Source: State Statistical Committee of the Republic of Azerbaijan, 2024

As presented in Table 5, the yield of apple production in the Quba–Khachmaz economic region for the period 2020–2024 is illustrated. Based on these statistical indicators, it is possible to analyze the overall dynamics of productivity within the region and identify key trends in yield performance over the observed years.

Table 6. *Overall dynamics of apple yield in the Quba–Khachmaz economic region*

Year	Yield (centners/ha)	Annual Increase (centners/ha)	Annual Increase (%)
2020	98.6	-	-
2021	99.5	+0.9	+0.9 %
2022	105.8	+6.3	+6.3 %
2023	115.4	+9.6	+9.1 %
2024	123.9	+8.5	+7.4 %

Over the past five years, apple yield in the Quba–Khachmaz economic region has increased by approximately 25 percent (from 98.6 to 123.9 centners per hectare). Although a decline has been observed in both orchard area and total production in recent years, the introduction of new apple varieties, along with innovative cultivation techniques and modern technologies, has significantly contributed to the improvement of orchard productivity. Based on the statistical data provided by the State Statistical Committee of the Republic of Azerbaijan, it is possible to conduct calculations grounded in current and reliable information. From the above observations, it can be concluded that the Compound Annual Growth Rate (CAGR) of apple yield in the Quba–Khachmaz economic region for the analyzed period is as follows:

$r = \left(\frac{16702.3}{21500.3}\right)^{\frac{1}{4}} - 1 \approx 0.78^{\frac{1}{4}} - 1 \approx 0.938 - 1 = -0.062 \approx -6.2\,\%$ (Compound Annual Growth Rate for Cultivated Area - CAGR)

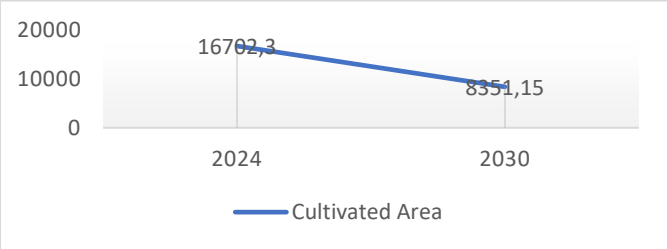
$r = \left(\frac{206882.3}{214326.8}\right)^{\frac{1}{4}} - 1 \approx 0.9^{\frac{1}{4}} - 1 \approx 0.974 - 1 = -0.026 \approx -2.6\,\%$ (Compound Annual Growth Rate for Production - CAGR)

$r = \left(\frac{123.9}{98.6}\right)^{\frac{1}{4}} - 1 \approx 25^{\frac{1}{4}} - 1 \approx 1.058 - 1 = 0.058 \approx 5.8\,\%$ (Compound Annual Growth Rate for Yield - CAGR)

Using the Compound Annual Growth Rate (CAGR) formula, calculations were carried out for the last four years in three directions: cultivated area, production, and yield. Based on this calculated data, it is possible to make a forecast for apple production in the Quba–Khachmaz economic region.

$Y_{2030} = 16702.3 \times (1 + (-0.062))^6 = 16702.3 \times (1 - 0.062)^6 \approx 16702.3 \times 0.9^6 \approx 16702.3 \times 0.5 \approx 8351.15\ ha$ (Projected cultivated area for 2030 based on the Compound Annual Growth Rate)

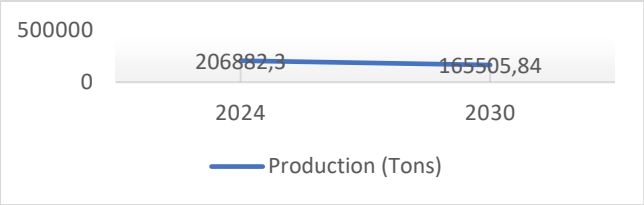
Graph 1. *Comparison of the existing (2024) and projected (2030) cultivated area indicators for the Quba–Khachmaz Economic Region*



During the period 2024–2030, the total cultivated area of apple orchards in the Quba–Khachmaz economic region is projected to decline from 16.7 thousand hectares to 8.35 thousand hectares, representing an approximate 50 percent decrease (see Graph 1). This change is primarily associated with structural adjustments in the agricultural sector and the gradual elimination of traditional orchards with low productivity. Farmers have increasingly shifted toward intensive and super-intensive orchard systems, which are based on modern technologies and offer higher yields. The development of such systems is also reflected in the Strategic Road Map on the Production and Processing of Agricultural Products in the Republic of Azerbaijan, approved by the Decree of the President of the Republic of Azerbaijan No. 1138, dated December 6, 2016 (https://e-qanun.az/framework/57124). According to the report of the Agricultural Research Center under the Ministry of Agriculture, intensive and super-intensive orchards currently account for about 14 percent of all orchards in Azerbaijan. Consequently, traditional horticulture is gradually being replaced by modern intensive systems. Despite the reduction in cultivated area, production volume has not decreased at the same rate, since the increase in yield indicators has helped stabilize overall output.

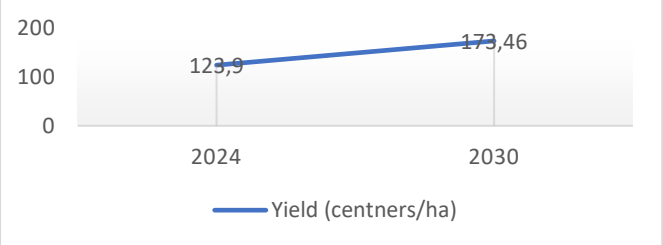
Therefore, this trend demonstrates rising efficiency in agricultural production and indicates a qualitative transformation in resource utilization within the sector.
$Y_{2030} = 206882.3 \times (1 + (-0.026))^6 = 206882.3 \times (1 - 0.026)^6 = 206882.3 \times 0.694^6 \approx 206882.3 \times 0.8 \approx 165505.84\ tons$ (Projected apple production for 2030 based on the Compound Annual Growth Rate)

Graph 2. *Comparison of the existing (2024) and projected (2030) apple production indicators for the Quba–Khachmaz Economic Region*



Between 2024 and 2030, the total volume of apple production in the Quba–Khachmaz economic region is projected to decrease from 206,882 tons to 165,505 tons, reflecting an approximate 20 percent decline. However, this reduction is considerably smaller compared to the nearly 50 percent decrease in cultivated area, indicating a relatively stable production dynamic. This situation suggests that while the structure of production is undergoing transformation, overall output remains stable due to increased productivity. Moreover, the observed improvement in yield contributes to the more efficient use of resources such as labor, water, and energy. Therefore, the decline in production volume should not be interpreted as an economic setback but rather as evidence of a transition toward a more efficient and resource-saving production model, emphasizing sustainability and optimization in agricultural management.
$Y_{2030} = 123.9 \times (1 + 0.058)^6 \approx 123.9 \times 1.4 \approx 173.46\ centners/ha$ (Projected apple yield for 2030 based on the Compound Annual Growth Rate)

Graph 3. *Comparison of the existing (2024) and projected (2030) apple yield indicators for the Quba–Khachmaz Economic Region*



During the same period, the yield of apple orchards in the Quba–Khachmaz economic region is projected to increase from 123.9 to 173.46 centners per hectare, representing an approximate 40 percent growth (see Graph 3). This improvement is associated with the widespread adoption of intensive horticultural technologies, the expansion of drip irrigation systems, the use of high-yielding rootstocks, and the cultivation of varieties adapted to local climatic conditions. According to the calculations, the average annual growth rate of yield is around 5.8 percent. This dynamic indicates that the application of modern agro-technologies enables a higher output per hectare, thereby offsetting the negative effects of reduced cultivated area on total production. One of the main reasons behind the transition to intensive and super-intensive orchard systems is precisely the pursuit of such benefits and the overall improvement of economic efficiency. As can be seen from Tables 1 and 3, the case of Quba District clearly illustrates this relationship. Between 2020 and 2024, the cultivated area decreased by

about 3,720 hectares, while total production declined by 12,408.8 tons, indicating a negative correlation. However, yield increased by 24.2 centners per hectare, showing a positive correlation, since the development of intensive and super-intensive orchards directly contributes to higher productivity. According to the Agricultural Research Center under the Ministry of Agriculture of the Republic of Azerbaijan, the total area of intensive and super-intensive apple orchards in Quba District alone now exceeds 1,000 hectares. Specifically, while traditional orchards typically contain up to 650 apple trees per hectare, intensive orchards include between 650 and 1,249 trees, and super-intensive orchards feature 1,250 trees or more per hectare (https://apa.az/aqrar-senaye-kompleksi/Azrbaycanda-nnvi-intensiv-v-superintensiv-tipli-meyv-baglarina-dair-tlblr-muyynlsib-colorredCDVLcolor-616079). In conclusion, technological innovations play a crucial role in enhancing agricultural efficiency and ensuring the stability of production, supporting the sustainable development of fruit growing in the Quba–Khachmaz economic region. In conclusion, technological innovations make a significant contribution to enhancing efficiency in agriculture and maintaining the stability of production.

The Quba–Khachmaz economic region stands out as one of the key pillars of Azerbaijan's fruit-growing potential. Although the total area of apple orchards in the region declined between 2020 and 2024, yield levels increased significantly. This fact demonstrates that agriculture in the region has shifted from a volume-based approach toward a quality- and efficiency-oriented production model. As a result of the more optimal use of resources, economic efficiency has improved, and the overall quality of production has increased.

The analyzed data lead to the following conclusions:

1. The study revealed that between 2020 and 2024, the total area of apple orchards decreased by 22 percent. This decline is mainly associated with the biological aging of old orchards, the fact that newly planted trees have not yet reached the fruit-bearing stage, and the transition of farmers to intensive production systems. Although the reduction in cultivated area might appear negative, it actually reflects structural renewal in agriculture, the adoption of modern technologies, and more purposeful resource utilization.
2. Statistical analysis of the five-year period showed that while total apple production in the Quba–Khachmaz region decreased from 214 thousand tons to 206 thousand tons, yield increased from 98.6 to 123.9 centners per hectare. Thus, despite the slight decline in production volume, the yield per hectare rose by 25 percent. This indicates that the region maintains efficiency through improvements in product quality and technological innovation.
3. The study found that production dynamics vary among districts. The Quba District continues to account for the largest share of total production, although it experienced a 10 percent decrease. In Khachmaz District, the decline was sharper, reaching about 25 percent. In contrast, Qusar District demonstrated over 50 percent growth due to the entry of new intensive orchards into production. These regional differences show that technological modernization and the level of agro-technical expertise play a decisive role in production efficiency.
4. Calculations based on the Compound Annual Growth Rate (CAGR) method reveal an interesting trend for 2030. It is projected that the area of apple orchards will decline from 16.7 thousand hectares to 8.35 thousand hectares, while yield will increase by 40 percent, reaching 173.46 centners per hectare. Production volume, however, will fall by only about 20 percent. These results indicate that in the future it will be possible to achieve higher output with less land, marking a shift from extensive to intensive agricultural development.
5. The findings suggest that apple production in the Quba–Khachmaz region has entered a quality-oriented phase. The reduction in cultivated area does not negatively affect the economic value of production, since more output is obtained per hectare. This process is accompanied by resource optimization, water and energy conservation, and an increase in labor productivity. As a result, agriculture is evolving into a model that achieves higher returns with lower resource consumption.

6. The development of intensive and super-intensive horticulture fully aligns with the state's *"Strategic Road Map for the Production and Processing of Agricultural Products."* By 2030, the main goal is the gradual replacement of traditional orchards with modern systems. This transition is crucial not only for economic stability but also for environmental sustainability. Ultimately, the reforms implemented in the region contribute to the formation of a sustainable agricultural model and the strengthening of an export-oriented fruit-growing sector in Azerbaijan.

REFERENCES

1. European Union (2015) *Agriculture, Forestry and Fishery Statistics.* Luxembourg: Publications Office of the European Union. Available at: http://ec.europa.eu/eurostat/documents/3217494/6639628/KS-FK-14-001-EN-N.pdf (Accessed: 30 April 2015).
2. World Apple and Pear Association (2015) *Apple and Pear Production by Country and Year (2003–2012).* Available at: http://www.wapa-association.org/asp/page_1.asp?doc_id=446 (Accessed: 30 April 2015).
3. Gasparatos, D., Roussos, P.A., Christofilopoulou, E. and Haidouti, C. (2011) 'Comparative effects of organic and conventional apple orchard management on soil chemical properties and plant mineral content under Mediterranean conditions', *Journal of Soil Science and Plant Nutrition,* 11, pp. 105–117.
4. Herencia, J.F., Ruiz, J.C., Morillo, E., Melero, S., Villaverde, J. and Maqueda, C. (2008) 'The effect of organic and mineral fertilization on micronutrient availability in soil', *Soil Science,* 173, pp. 69–80.
5. Stockdale, E.A., Lampkin, N.H., Hovi, M., Keatinge, R., Lennartsson, E.K.M., Macdonald, D.W., Padel, S., Tattersall, F.H., Wolfe, M.S. and Watson, C.A. (2001) 'Agronomic and environmental implications of organic farming systems', *Advances in Agronomy*, 70, pp. 261–327.
6. Murphy, K. (2012) 'The social pillar of sustainable development: A literature review and framework for policy analysis', *Sustainability: Science, Practice and Policy*, 8, pp. 15–29.
7. Bravin, E., Kilchenmann, A. and Leumann, M. (2015) *Six hypotheses for profitable apple production based on the economic work-package within the ISAFRUIT Project.* Available at: http://www.jhortscib.com/isafruit/isa_pp164_167.pdf (Accessed: 30 April 2015).
8. Gul, M. (2005) 'Technical efficiency and productivity of apple farming in Antalya province of Turkey', *Pakistan Journal of Biological Sciences,* 8, pp. 1533–1540.
9. Reganold, J.P., Glover, D.J., Andrews, P.K. and Hinman, H.R. (2001) 'Sustainability of three apple production systems', *Nature,* 410, pp. 926–930.
10. DeJong, T.M., Tsuji, W., Doyle, J.F. and Grossman, Y.L. (1999) 'Comparative economic efficiency of four peach production systems in California', *HortScience,* 34, pp. 73–78.
11. Investopedia (n.d.) *Compound Annual Growth Rate (CAGR).* Available at: https://www.investopedia.com/terms/c/cagr.asp.
12. *State Statistical Committee of the Republic of Azerbaijan, 2024*
13. (https://apa.az/aqrar-senaye-kompleksi/Azrbaycanda-nnvi-intensiv-v-superintensiv-tipli-meyv-baglarina-dair-tlblr-muyynlsib-colorredCDVLcolor-616079).