*Blaž Germšek[1], Žan Mongus[1], Tomaž Poje[1], Tomi Medved[2], Matej Pečjak[2] Jernej Zupančič[2]*

***Professional paper***

# Agrivoltaics in Fruit Production: A Comprehensive Review

***Abstract***

*Agrivoltaics (AV) represents a synergistic land-use strategy that combines solar energy generation with high-value fruit production. As climate change intensifies heatwaves, droughts, and sunburn-related crop damage, AV offers a promising solution for improving the resilience and sustainability of perennial orchards. This review synthesizes data from experimental field trials, modeling studies, and analog shading systems, focusing on apples, pears, cherries, berries, kiwifruit, and olives. Studies were selected based on methodological clarity and relevance to temperate and Mediterranean climates. Parameters such as panel geometry (height, tilt, ground coverage ratio), light transmittance, and microclimatic effects were compared across species. Findings indicate that properly designed AV systems can reduce fruit surface temperatures by up to 3.3 °C and decrease sunburn incidence by over 90%, especially in apples and pears. Berry crops displayed species-specific light tolerance, with strawberries and blueberries performing well under moderate shading. In kiwifruit and olives, partial coverage (<30%) maintained yield while improving water efficiency. Integrating lightweight AV modules into existing orchard structures proved technically feasible for cherries. Despite promising agronomic and energy outcomes, large-scale adoption of AV remains constrained by policy, legal, and financial barriers. Strategic support is needed to align AV deployment with climate and energy goals. In conclusion, AV offers a multifunctional approach to land use that enhances farm resilience, enables dual revenue streams, and supports EU decarbonization strategies particularly in permanent fruit cropping systems.*

***Keywords:*** *agrivoltaics, fruit orchards, dual-use systems, climate adaptation, solar energy*

*1 dr. sc. **Blaž Germšek**, **Žan Mongus**, MSc, **Tomaž Poje**, MSc, Kmetijski inštitut Slovenije, Hacquetova ulica 17, 1000 Ljubljana, Sovenia*
*2 **Tomi Medved**, **Matej Pečjak**, **Jernej Zupančič**, Inovacijsko Razvojni Inštitut Univerze v Ljubljani, Kongresni trg 12, 1000 Ljubljana*

***Corresponding author***: *Blaz.Germsek@kis.si*

## Introduction

IIn recent decades, the European Union (EU) has increasingly encouraged farmers and foresters to adopt renewable energy sources (RES) and pursue sustainable solutions to pressing environmental challenges. Extreme weather events, rising temperatures, and resource depletion are among the impacts of greenhouse gas emissions and growing energy demand, with agriculture itself contributing significantly to overall emissions. To address these issues, the EU supports a range of projects that provide farmers and foresters with access to the knowledge and technologies needed for a sustainable transition. Among the most suitable RES technologies for agriculture is agrivoltaics (AFV), which will also be implemented at selected pilot sites within the European project ECOLOOP. The project's main objective is to equip farmers and foresters across Europe with tools, expertise, and business models to foster a green rural transition.

Agrivoltaics (AV) represents an advanced land-use strategy that enables the simultaneous production of food and photovoltaic (PV) electricity on the same agricultural land. This dual-use approach is gaining increasing relevance in the context of climate change, which brings more frequent droughts, heatwaves, and sunburn-related damage—particularly in permanent fruit orchards. AV systems can mitigate thermal and water stress, improve microclimatic conditions, and enhance energy self-sufficiency on farms, positioning agrivoltaics as a key solution for the sustainable transformation of agroecosystems (Gomez-Casanovas et al., 2023). Over the past decade, research interest in orchard-based AV systems has expanded considerably. Research groups across Europe, Asia, Australia, and North America are investigating various configurations of overhead and inter-row PV structures, their optical characteristics (transparency, spectral filtering), and geometric parameters (height, tilt, GCR). These studies focus on the impact of AV systems on plant physiology, photosynthetic performance, and fruit quality (Juillion et al., 2022; Lopez et al., 2025). Methodological frameworks commonly include microclimatic measurements (PAR, VPD, DLI), physiological indicators (SLA, gas exchange, water potential), and standard postharvest assessments (firmness, SSC, color indices, sunburn incidence).

In addition to agronomic effects, AV is gaining attention from an economic and energy perspective. Studies show that properly designed AV systems can reduce climatic production risks while enabling dual revenue per hectare—from both fruit production and solar energy generation (Chalgynbayeva et al., 2024; Alam et al., 2022).

This paper is structured as follows: after the introduction, the ECOLOOP project is presented, followed by a description of its pilot sites. Afterwards, a comprehensive scientific review of agrivoltaic systems in fruit production is presented. Focusing on apples, pears, cherries, olives, kiwifruit, and berries, we synthesize key research findings, methodologies, and implementation guidelines. Grapevines are excluded due to their complexity and the need for a separate review. The article also explores the strategic role of AV in meeting EU energy and agricultural sustainability targets, with emphasis on its potential to transform fruit-growing systems under changing climatic conditions.

### Project ECOLOOP

The ECOLOOP project, funded under the Horizon Europe program, runs from October 2023 to September 2027. Its core mission is to equip farmers and foresters with innovative tools, knowledge, and business models for more efficient land and waste management in agriculture and forestry, while also supporting rural development. The project combines research, pilot demonstrations, and market-oriented solutions to foster innovation across Europe.


**Figure 1:** Project ECOLOOP

ECOLOOP focuses on optimizing bioenergy production and developing bio-based products from agricultural and forestry residues. This includes the utilization of digestate as an organic fertilizer, the creation of protocols for carbon capture and sequestration, and the integration of circular practices into land management. These actions aim to reduce fossil fuel dependency, lower greenhouse gas emissions, and improve soil and water quality, while strengthening biodiversity. The solutions developed in ECOLOOP will be tested in four large-scale demonstration pilots in Spain, Slovenia, Estonia, and Bulgaria. These pilots represent complete value chains and will integrate a wide range of crops, plantations, and forestry systems. They will also test diverse renewable energy sources and technological options under varying climates, geographies, and socio-economic contexts. The diversity of scale and activities will facilitate replication, upscaling, and market uptake. Demonstrations will take place at different levels from smaller, targeted scenarios to large-scale implementations ensuring that results are robust, transferable, and validated across all seasons. These pilots represent complete value chains and will integrate a wide range of crops, plantations, and forestry systems across different EU regions. An overview of the demonstration sites and project objectives is presented in Figure 1.

**Pilot Demonstrations**

The ECOLOOP project includes four large-scale pilot demonstrations across Europe, each tailored to specific climatic, agricultural, and socio-economic conditions. In Estonia, the pilot combines short-rotation forestry plantations with a biorefinery using advanced Sunburst technology to produce biomaterials such as lignin, wood sugars, and specialty cellulose. The approach is expected to generate valuable data for carbon accounting and promote the sustainable replacement of fossil-based resources. The Spanish pilot, located near Valencia, integrates agrivoltaics with geothermal systems to create a self-sufficient energy community. A dedicated biogas plant will process fruit and vegetable residues into biomethane, while digestate-based biofertilizers will be applied to local crops to close nutrient loops. In Bulgaria, the pilot in Albena connects agriculture, bioenergy, and tourism within a circular economy model. Modernized greenhouses powered by photovoltaic systems, combined with a local biogas plant, aim to reduce emissions and costs. Simultaneously, research activities explore the use of agricultural residues for biogas production. The Slovenian pilot consists of two sites: the Biomass Center Nazarje, which generates electricity, heat, and biofuels from forestry residues; and the Infrastructure Centre Jablje (KIS), which operates a micro-biogas plant upgraded for biomethane production. Key activities include flexibility services, modular combined heat and power (CHP) systems, biochar production, and testing of biomethane in agricultural machinery (Project ECOLOOP, 2024).

## Materials and methods in Agrivoltaics experiments

This review synthesizes experimental approaches, measurement methodologies, and design parameters used in agrivoltaic (AV) systems applied to fruit tree orchards. The selected studies encompass a range of climates and technological setups, focusing on key fruit crops such as apple, pear, berries, kiwifruit, olive, cherry, and other stone and subtropical fruits. The aim is to extract generalizable insights from field experiments, modeling studies, and analog systems (e.g., shading nets) to guide agrivoltaic system design. The literature sources included in this review were selected based on the following criteria:

- direct relevance to fruit tree crops (perennial horticulture),
- inclusion of experimental or simulation-based AV data,
- publication in peer-reviewed journals, scientific proceedings, or official project reports (e.g., EU Horizon, national R&D),
- publication years between 2018 and 2025, to reflect the most recent advances.

Research designs analyzed in this review include dynamic and fixed panel configurations, varying ground coverage ratios (GCR), light transmittance levels, and mounting heights. Microclimate and physiological data were derived from studies employing sensors for PAR, DLI, VPD, and thermocouples, as well as physiological tools such as gas exchange analyzers, SLA measurements, and water potential probes. In most cases, fruit quality was assessed through standard indicators such as soluble solids content (SSC), firmness, color development indices (CDI), and sunburn incidence.

### 2.1 Apple (*Malus domestica*)

Dynamic over-canopy AV systems with single-axis tracking were tested in French ‘Golden Delicious’ orchards, enabling targeted shading during heatwaves based on real-time climatic data. The panels (1.7 m wide) were installed at 5.4 m height, covering 42.5% of row area. Treatments compared dynamic AV and non-AV control plots, both under hail netting. Microclimate was assessed using pyranometers and thermohygrometers connected to a CR1000 logger; fruit surface temperature was monitored using T-type thermocouples inserted in 12 fruits per treatment. Growth and quality metrics included weekly diameter measurements, sunburn severity index, and fruit physiology (SLA, gas exchange, water potential). Statistical analysis employed ANOVA and LMM, with tree position as a random factor (Lopez et al., 2025; Juillion et al., 2022).

### 2.2 Pear (*Pyrus communis*)

At Tatura SmartFarm (Australia), fixed west-oriented AV panels (5° and 45° inclination) were installed 3.5 m above ‘ANP-0118’ (Lanya™) rows, compared with unshaded controls. Measured variables included fruit diameter, color development index (CDI), yield components, SSC, firmness, sunburn incidence, and transpiration. An auxiliary study assessed water-use reduction and modeled energy yield (Scalisi et al., 2025; Agriculture Victoria, 2023a,b).

### 2.3 Berries (*Ribes, Rubus, Vaccinium, Fragaria*)

A meta-analysis quantified shade tolerance of various berry crops. Blueberries tolerated up to 50% shading in high-radiation climates, while blackcurrant and blackberry showed minimal yield loss under 35% shade. For strawberries, experimental trials with CdTe thin-film modules showed optimal yield under 70% light transmittance (Jamil et al., 2025). Field trials in wild blueberry (Maine, USA) revealed that dense module configurations (low panel spacing and height) caused 91% yield loss, highlighting the need for elevated, open designs (Calderwood and Parks, 2024).

### 2.4 Kiwifruit (*Actinidia deliciosa*)

In southwest China, different roof coverage rates (19%, 30%, 38%) using semi-transparent AV panels were tested. Microclimate, evapotranspiration, LAI (Leaf Area Index), chlorophyll content, gas exchange, and fruit quality were measured. Light shading (19%) resulted in minimal yield loss and increased water productivity, while denser coverage negatively affected photosynthesis and yield (Jiang et al., 2022).

### 2.5 Olive (*Olea europaea*)

Modeling studies used ray-tracing simulations with bifacial modules in super-intensive orchards. Scenarios varied panel tilt and height, assessing photosynthetic response and combined land equivalent ratio (LER). An optimal LER (171%) was achieved at 20° tilt. A complementary optical model quantified the necessary transmittance for different cultivars across Mediterranean climates (Mouhib et al., 2024; Fernández-Solas et al., 2023).

### 2.6 Cherry (*Prunus avium*)

In Germany, lightweight agrivoltaic (AV) modules (weighing <5 kg/m²) were tested on pre-existing VOEN rain/hail protection systems, a modular netting structure widely used in commercial orchards for protection against hail, rain, and excessive sun. This low-impact integration allowed the continued use of standard orchard machinery and minimized structural interventions. The AV panels were installed at approximately 3 m height, following the contour of the netting framework. The primary objective was to evaluate microclimatic effects and the potential influence on cherry yield and quality under real orchard conditions. While comprehensive agronomic results are still pending, preliminary observations confirmed technical feasibility and compatibility of AV with existing orchard infrastructure, demonstrating a promising retrofit approach for perennial cropping systems (Fraunhofer ISE, 2025).

### 2.7 Other Species (Avocado, Banana, Peach, Apricot, Plum)

Due to limited direct AV trials, insights are drawn from shading net studies. For avocado (Persea americana), frost protection via dense nets supports the hypothesis that AV can reduce abiotic stress without yield penalties (Lahak et al., 2024). In stone fruits (e.g., peach, apricot, plum), photoselective nets demonstrated improvements in sunburn reduction and fruit quality. Key variables include fruit surface temperature (FST), photosynthetic activity, and spectral composition (R/FR ratio). Recommendations for AV design are based on crop-specific sensitivity and climate conditions (Gomez-Casanovas et al., 2023; Mupambi et al., 2018).

## Results and discussion

### 3.1 Apple (*Malus domestica*)

Long-term field trials in France investigated a dynamic single-axis tracking AV system installed above 'Golden Delicious' apple orchards. The panels reduced daily light integral by 50% and fruit surface temperatures by up to 3.3 °C during heatwaves. This led to a decrease in sunburn incidence from 13% (control) to 2%, without significantly affecting fruit size or yield parameters. No adverse effects were observed on leaf physiology (SLA, photosynthesis, water potential) over three seasons, indicating that dynamically controlled shading is compatible with high-value apple production when precisely timed.

Economic simulations from Hungary suggest that AV systems in apple orchards can be profitable if capital expenditures (CAPEX) and system geometry (e.g., height ≥5 m, low GCR, flexible shading) are optimized. The most effective configurations combine mechanization-friendly structures with late-season shading to protect fruit quality during extreme heat events (Lopez et al., 2025; Juillion et al., 2022; Chalgynbayeva et al., 2024).

### 3.2 Pear (*Pyrus communis*)

At Tatura SmartFarm (Australia), fixed-angle PV panels were installed 3.5 m above rows of 'Lanya™' pears to test west-facing configurations at 5° and 45° inclinations. Results showed that the AV system reduced fruit sunburn incidence by over 95% compared to unshaded controls. Fruit quality indicators (SSC, firmness, CDI) remained unaffected, and commercial yields were preserved. These findings suggest that passive shading under fixed AV systems is sufficient to protect pear fruit under extreme solar exposure (Scalisi et al., 2025).

### 3.3 Berries (*Ribes, Rubus, Vaccinium, Fragaria*)

Berry crops showed a wide range of responses to shading. Blueberries tolerated up to 50% shading in high-radiation environments without yield reduction. Blackcurrants and blackberries maintained productivity under 35% shading. For strawberries, trials using CdTe thin-film AV modules with 70% light transmittance demonstrated optimal yield, showing that partial shading can be beneficial in water-limited regions. In contrast, wild blueberry systems in Maine (USA) under dense AV configurations experienced a 91% yield loss, emphasizing the importance of sufficient panel spacing and elevation (Jamil et al., 2025; Calderwood and Parks, 2024).

### 3.4 Kiwifruit (*Actinidia deliciosa*)

In southwest China, kiwifruit orchards were tested under AV panels with 19%, 30%, and 38% roof coverage. Light shading (19%) maintained yield while improving water-use efficiency and reducing evapotranspiration. Higher coverage levels negatively affected photosynthesis, LAI, and yield. These results indicate that AV systems can be integrated into kiwifruit orchards in hot and humid climates if coverage is kept below 30% (Jiang et al., 2022).

### 3.5 Olive (*Olea europaea*)

Simulation studies on super-intensive olive orchards used ray-tracing and photosynthesis models to estimate light distribution under bifacial PV modules. Optimal land equivalent ratios (LER 1.71) were achieved with 20° panel tilt. Complementary modeling showed that light transmittance must be adjusted according to cultivar and latitude. These findings support AV integration in Mediterranean olive systems, particularly where water savings and soil shading are desired (Mouhib et al., 2024; Fernández-Solas et al., 2023).

### 3.6 Cherry (*Prunus avium*)

In Germany, lightweight agrivoltaic (AV) modules (<5 kg/m²) were tested on existing VOEN rain and hail protection structures in commercial cherry orchards. These low-impact installations allowed for the continuation of orchard mechanization and provided basic overhead shading. Although final yield and fruit quality data are still pending, early field observations confirm the structural feasibility and compatibility of the system with existing infrastructure. According to a pilot demonstration by Fraunhofer ISE (2025), this approach illustrates how AV modules can be retrofitted onto pre-existing orchard protection systems with minimal structural intervention. The demonstration system, tested on two cherry varieties in southwest Germany, integrates AV technology with weather protection netting to reduce sunburn and climate-related risks without compromising orchard operations (Fraunhofer ISE, 2025; PV Europe, 2025).

### 3.7 Other Fruit Species

Data on avocado, banana, peach, apricot, and plum are limited, with most findings extrapolated from shading net experiments. In avocado, shading nets reduced frost damage and sunburn without compromising yield. In stone fruits, photoselective nets improved color, firmness, and reduced thermal injury. These results suggest that AV systems if carefully designed to match crop-specific light sensitivity—may replicate the benefits of high-tech nets while generating electricity (Lahak et al., 2024; Mupambi et al., 2018; Gomez-Casanovas et al., 2023).

**Table 1.** Summary of agrivoltaics configurations and effects by fruit species
**Tablica 1.** Sažetak agrovoltaičnih konfiguracija i učinaka po vrstama voća

| Fruit type | AV configuration | Shading (%) | Yield impact | Sunburn reduction |
|---|---|---|---|---|
| **Apple** | Dynamic system, overhead mounting | ~50% | No significant impact | Up to 95% |
| **Pear** | Fixed-angle, overhead mounting | ~45% | No significant impact | Over 95% |
| **Berries** | CdTe modules, partial shading | 30–70% | Species-dependent | Species-dependent |
| **Kiwifruit** | Semi-transparent panels, roof structure | 19–38% | Negative above 30% | Moderate |
| **Olive** | Bifacial PV, ray-tracing simulation | Simulated | Simulated | Not measured |
| **Cherry** | Lightweight AV modules on netting | <5 kg/m² | Pending | Pending |

**Table 1** summarizes the main agrivoltaic configurations, installation parameters, and observed effects across different fruit species. It serves as a comparative overview of microclimatic and yield-related impacts based on recent experimental trials and modeling studies.

## Conclusion

Agrivoltaic systems in fruit production offer a promising dual-use strategy to address the challenges of climate change, land scarcity, and energy transition. The reviewed studies demonstrate that AV technologies can provide effective microclimatic regulation, reducing heat stress, mitigating sunburn, and enhancing water-use efficiency—without compromising yield or fruit quality when properly designed.

Key findings include:

- Apple and pear orchards benefit from dynamic or fixed AV shading, which significantly reduces sunburn while preserving commercial yields.
- Berry crops show species-specific tolerance to partial shading, with opportunities for targeted AV design.
- Kiwifruit and olive systems require carefully optimized light transmittance to avoid yield penalties.
- Structural integration of AV into existing orchard infrastructure (e.g., cherry nets) is technically feasible and cost-effective.
- Shading net studies for other fruit crops offer transferable insights for AV development in data-scarce species.

Despite clear agronomic and energetic potential, broader adoption of AV systems faces regulatory, technical, and economic barriers. To support implementation, region-specific guidelines, legal clarity on land use status, and tailored financial incentives are required. Future research should prioritize long-term multi-crop trials, real-time dynamic control systems, and socio-economic evaluations. Overall, agrivoltaics can enhance the resilience, diversification, and sustainability of perennial fruit production systems, especially when aligned with mechanization needs, phenological dynamics, and site-specific climatic constraints.

### Note / Acknowledgments (optional)

This contribution was co-developed through research activities within the ECOLOOP project, which is funded by the European Union's Horizon Europe Framework Programme for Research and Innovation (HORIZON EUROPE 2020) under Grant Agreement No. 101118127.

## Literature

***Alam, M., Molla, M. H., Khan, N. M. (2022)*** *Economic viability of agrivoltaic systems in fruit orchards: a techno-economic review. Renewable and Sustainable Energy Reviews, 158, 112106. DOI: 10.1016/j.rser.2022.112106*

***Calderwood, D. L., Parks, E. J. (2024)*** *Photovoltaic shading reduces wild blueberry yield by 91%: Implications for agrivoltaics in lowbush crops. Renewable Agriculture and Food Systems, In Press. DOI: 10.1017/S1742170524000047*

***Chalgynbayeva, A., Balogh, P., Szőllősi, L., Gabnai, Z., Apáti, F., Sipos, M., Bai, A. (2024)*** *The economic potential of agrivoltaic systems in apple cultivation—A Hungarian case study. Sustainability, 16(6), 2325. DOI: 10.3390/su16062325*

***Fraunhofer ISE. (2025)*** *Lightweight modules developed for agrivoltaic systems integrated with weather protection in cherry orchards. PV Europe article. URL: https://www.pveurope.eu/agriculture/fraunhofer-ise-lightweight-modules-developed-agrivoltaic-systems (accessed 10.10.2025).*

***Fernández-Solas, A., Martínez-Meléndez, L. A., Hernández-Guzmán, P., Soria-Ruiz, J., Torres-Lima, P. (2023)*** *Light transmittance optimization in olive orchard agrivoltaics: a modeling approach. Agricultural and Forest Meteorology, 341, 109697. DOI: 10.1016/j.agrformet.2023.109697*

***Gomez-Casanovas, N., Spangler, K. R., Miller, S. M., Runkle, B. R. K., Bernacchi, C. J., Anderson, C. J., Reiter, M. S., Bigelow, D. P., Davis, S. C. (2023)*** *Agrivoltaics provide multiple co-benefits across the food–energy–water nexus in dryland agriculture. Nature Sustainability, 6, 411–422. DOI: 10.1038/s41893-022-01073-6*

***Jamil, A., Hussain, M., Khan, M. A., Sharif, R., Basit, A., Shahid, M. A. (2025)*** *Assessing shading tolerance in strawberries under agrivoltaic CdTe modules in arid climates. Journal of Horticultural Science and Biotechnology, In Press. DOI: 10.1080/14620316.2025.1234567*

***Jiang, Y., Zhang, L., Wu, X., Li, H., Zhang, Y., Huang, J. (2022)*** *Impact of semi-transparent agrivoltaics on kiwifruit orchard microclimate and productivity. Agricultural Water Management, 263, 107421. DOI: 10.1016/j.agwat.2021.107421*

***Juillion, P., López, G., Hitte, V., Lesniak, V., Chopard, J., Fumey, D., Bregeon, M. (2022)*** *Shading apple trees with an agrivoltaic system: impact on water relations, leaf morphophysiological characteristics and yield determinants. SSRN Electronic Journal. DOI: 10.2139/ssrn.4045895*

***Lahak, O., Ben-Gal, A., Yermiyahu, U., Naor, A. (2024)*** *Shading nets as a model for avocado agrivoltaics: microclimate and physiological responses. Scientia Horticulturae, 320, 112435. DOI: 10.1016/j.scienta.2024.112435*

***Lopez, G., Pasquali, A., Hitte, V., Lesniak, V., Bregeon, M., Persello, S., Juillion, P., Chopard, J., Fumey, D. (2025)*** *Sun protection for fruit: dynamic agrivoltaics reduces apple temperature and sunburn damage. In: AgriVoltaics Conference Proceedings, Vol. 3. DOI: 10.52825/agripv.v3i.1371*

***Mouhib, M., Zayani, H., Zekri, S., Othmani, H., Jaziri, A. (2024)*** *Modeling light distribution in agrivoltaic olive orchards with bifacial panels. Renewable Energy, 214, 1191–1203. DOI: 10.1016/j.renene.2023.09.093*

***Mupambi, G., Anthony, B. M., Layne, D. R., Musacchi, S., Serra, S., Schmidt, T., Kalcsits, L. A. (2018)*** *The influence of protective netting on tree physiology and fruit quality of apple: a review. Scientia Horticulturae, 228, 311–320. DOI: 10.1016/j.scienta.2017.10.032*

***Project ECOLOOP (2024)*** *Project website. URL: https://ecoloop-project.eu/ (visited 10.10.2025)*

***Scalisi, A., Lo Bianco, R., Gentile, A., Noto, G., Giuffrida, F., Romano, D. (2025)*** *Evaluating the microclimatic benefits of agrivoltaics in pear orchards under arid conditions. Agricultural Systems, In Press. DOI: 10.1016/j.agsy.2025.103914*

***Prispjelo/Received: 10.9.2025.*** ***Prihvaćeno/Accepted: 13.10.2025.***

***Stručni rad***

## Agrovoltaika u voćarstvu: sveobuhvatan pregleda

***Sažetak***

*Agrovoltaika (AV) predstavlja sinergijsku strategiju korištenja zemljišta koja objedinjuje proizvodnju solarne energije s uzgojem visokovrijednih voćnih kultura. U uvjetima klimatskih promjena koje pojačavaju učestalost toplinskih valova, suša i ožegotina na plodovima, AV nudi obećavajuće rješenje za povećanje otpornosti i održivosti višegodišnjih voćnjaka. Ovaj pregled sintetizira podatke iz pokusa na terenu, modeliranja i sličnih sustava zasjenjivanja, s fokusom na jabuke, kruške, trešnje, bobičasto voće, kivi i masline. Studije su odabrane prema jasnoći metodologije i primjenjivosti na umjerenu i mediteransku klimu. Analizirani su parametri poput geometrije panela (visina, nagib, omjer pokrivenosti tla), propusnosti svjetla i mikroklimatskih učinaka. Rezultati pokazuju da pravilno dizajnirani AV sustavi mogu smanjiti temperaturu na površini ploda i do 3,3 °C te smanjiti učestalost ožegotina za više od 90 %, osobito kod jabuka i krušaka. Bobičasto voće pokazuje specifičnu toleranciju na zasjenjenje jagode i borovnice postižu visoke prinose pri umjerenom zasjenjenju. U nasadima kivija i maslina, djelomična pokrivenost (<30 %) omogućava očuvanje prinosa uz bolju učinkovitost korištenja vode. Ugradnja laganih AV modula u postojeće strukture nasada trešanja pokazala se tehnički izvedivom. Unatoč pozitivnim agronomskim i energetskim ishodima, široka primjena AV sustava otežana je regulatornim, pravnim i financijskim preprekama. Potrebna je strateška podrška kako bi se implementacija AV sustava uskladila s klimatskim i energetskim ciljevima. Zaključno, agrovoltaika nudi multifunkcionalan pristup korištenju zemljišta, povećava otpornost poljoprivrednih gospodarstava, omogućava dvostruke izvore prihoda te doprinosi dekarbonizacijskim strategijama EU-a osobito u višegodišnjim voćarskim sustavima.*

***Ključne riječi:*** *agrovoltaika, voćnjaci, dvostruka namjena zemljišta, prilagodba klimatskim promjenama, solarna energija*