

PROGRESS

Promoting Green Deal Readiness in
the Eastern Partnership Countries



On behalf of:



of the Federal Republic of Germany



CATALOGUE OF GOOD TECHNOLOGIES AND PRACTICES

for the adaptation of the horticulture
sector to climate change
prepared within the framework of the
PROGRESS project

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CONTENT

Aeroponics	4
Agrovoltaics	5
Anti-Hydrofluorocarbon (HFC) Technologies	6
Autonomous Energy Supply	7
Biogas	8
Biofuels	9
Carbon credits	10
Certification	11
Composting	13
Cover crops	14
Crop rotation	15
Early warning system	16
Eco-friendly drainage systems	18
Eco-friendly packaging	19
Electric transport	21
Export	22
Geodesic dome greenhouses	24
Green ammonia	25
Hail and bird nets	26
Hail and rain protection wraps	27
Hydroponics	28
Marketing	30
Mulching	32
Nets + films	33
No-Till	34
Organic fertilisers and plant protection products	35
Pest-resistant crops	37
Precision and drip irrigation	39
Precision farming	40
Precision fertilizer application	41
Protective shelterbelts	42
Rainwater harvesting	43
Reduced pesticide use	45
Reusable packaging	46
Row protection systems	47
Soil retention techniques in orchard rows	48
Varieties adapted to the region	49
Vertical farms	50
Water recycling	51

AEROPONICS

Application Area

Agricultural crop cultivation
(strawberries, raspberries)

Implementation Time

Medium

Availability in the Country

Available¹



Photo: Nadiya Lyadetska

Aeroponics is an innovative method of growing plants without soil or substrates, in which nutrients are delivered to the roots in the form of an aerosol mist. The plants are suspended in air, and their roots are periodically sprayed with a nutrient solution that ensures proper nourishment and development. This technology allows for the creation of fully automated plant-growing systems that are simpler than traditional substrate-based hydroponic systems². Aeroponic systems are often installed in greenhouses, which typically require a significant amount of electricity.

Adaptation/Mitigation Benefits

Significant water savings compared to traditional farming (a); Resistance to adverse weather conditions (a); Nutrient efficiency (a, m); Mechanization (no need for tractors or large agricultural machinery) (m); Reduced need for herbicides and pesticides (no weeds present) (m)³

Environmental and/or Socio-Economic Benefits

The produce is free from nitrates and pesticides; Space savings, job creation (salaries, taxes).

Financial Characteristics

The installation of an aeroponic system can be quite expensive, especially for large-scale projects. However, due to water savings and increased yields, aeroponics can provide a faster return on investment.

1. In a study conducted in a 72 m² greenhouse, the costs and revenues from aeroponic strawberry cultivation using the Ground Heat Exchanger (GHE) system were analyzed over one production cycle. According to this analysis, the projected gross income was \$3,461, while the total production costs amounted to \$2,096⁴.
2. Greenhouse (10 acres) of lettuce: one-time investment – \$288,000, income – \$315,000 per year, expenses – \$172,000, gross profit – \$143,000, payback period – approximately 3 years. Tomatoes: one-time investment – \$233,000, income – \$274,000, expenses – \$113,000, gross profit – \$161,000, payback period – approximately 3 years⁵.

¹ Aeroponics: A Paradise for Plants [in Ukrainian]. Nadiya Lyadetska. Propozytsiya. <https://propozitsiya.com/ua/aeroponika-ray-dlya-roslyn>

² Hydroponics in Ukraine [in Ukrainian]. Alfagro. <https://alfagro.com.ua/uk/gidroponika-v-ukra-ni/>

³ Hydroponics in Ukraine [in Ukrainian]. Alfagro. <https://alfagro.com.ua/uk/gidroponika-v-ukra-ni/>

⁴ Pascual, Christopher & Agulto, I & Espino, A & Malamug, Vitaliana. (2019). Effect of ground heat exchanger for root-zone cooling on the growth and yield of aeroponically-grown strawberry plant under tropical greenhouse condition. IOP Conference Series: Earth and Environmental Science. https://www.researchgate.net/figure/Cost-and-return-analysis-of-aeroponically-grown-strawberry-plants-using-GHE-at-72-m-2_tbl1_335673486

⁵ Aeroponics allows for between 4 and 14 harvests per year [in Ukrainian]. AgroReview. <https://agoreview.com/content/aeroponika-daye-zmohu-otrymuvaty-vid-4-do-14-urozhayiv-na-rik/>



AGROVOLTAICS

Application Area

Agricultural crop cultivation

Implementation Time

Medium

Availability in the Country

Available^{6 7 8}

Photo: Lisamiri

Agrovoltaics is an innovative approach to solar energy production that combines agricultural crop cultivation with electricity generation through solar panels. This technology enables the simultaneous use of land for food production and the generation of clean energy. Solar panels are installed on specialized structures above the fields, providing shade for the crops and reducing excessive water evaporation. The panels generate electricity that can be used to meet the farm's energy needs or be sold to the grid.

Adaptation/Mitigation Benefits

Shade from solar panels can increase the yield of certain crops by reducing excessive solar radiation and lowering soil temperature (a); provides the farm with energy for its own needs (m).

Environmental and/or Socio-Economic Benefits

Rational use of land resources; job creation (taxes, salaries).

Financial Characteristics

The cost of installing an agrovoltaic system depends on the scale of the project and the type of solar panels used. In general, the price of a solar panel is approximately €320–350 per kW^{9 10}. For an average farm, the system cost may range from €50,000 to €500,000 depending on the capacity. The payback period of an agrovoltaic project depends on the size and type of the farm but can be up to 10 years depending on the electricity price level.

⁶ Instead of gas and coal – solar farming and agrivoltaics in Ukraine and around the world [in Ukrainian]. EastFruit. <https://east-fruit.com/uk/plodoovochevyi-biznes/istorii-uk/zamist-hazu-ta-vuhillya-sonyachne-fermerstvo-ta-ahrovoltayika-v-ukrayini-ta-sviti-foto/>

⁷ Expensive, complicated, unprofitable and other myths about agrivoltaics in Ukraine [in Ukrainian]. EastFruit. <https://east-fruit.com/uk/plodoovochevyi-biznes/tehnologii-uk/doroho-skladno-nevyhidno-ta-inshi-mify-ahrovoltayiky-v-ukrayini/>

⁸ Climate change is prompting Ukrainian farmers to increase their use of agrivoltaics [in Ukrainian]. Olena Basanets. SuperAgronom.com. <https://superagronom.com/news/20106-zmini-klimatu-sponukayut-ukrayinskih-agrariyiv-naroschuvati-vikoristannya-agrovoltayiki>

⁹ Solar power station kit (panels) [in Ukrainian]. Solar Garden. https://www.solargarden.com.ua/product-category/komplekty/?_attribute18=150-kvt

¹⁰ Solar power station – 30 kW Medium [in Ukrainian]. Pravylnе elektrozhylennya. <https://prel.prom.ua/p495791096-sonyachna-elektrostantsiya-kvt.html>

ANTI-HYDROFLUOROCARBON (HFC) TECHNOLOGIES

Photo: Department of Environmental Conservation



Application Area

Agricultural crop cultivation

Implementation Time

Medium

Availability in the Country

Available



Anti-Hydrofluorocarbon (HFC) Technologies in Agricultural Product Processing:

These technologies aim to reduce the use of hydrofluorocarbons (HFCs), which are potent greenhouse gases. The adaptation to the Kigali Amendment requirements and European regulations regarding the use of HFCs is crucial in this context.

Use of Natural Refrigerants::

- Ammonia (R717): Effective for cooling and freezing products, it has zero ozone depletion potential.
- Carbon Dioxide (R744): Used in refrigeration systems, particularly in supermarkets for food storage.
- Hydrocarbons (propane, isobutane): Used in small refrigeration units, such as ice cream display cases.

Adaptation/Mitigation Benefits

Reduction of greenhouse gas emissions and decrease in environmental footprint (m)

Environmental and/or Socio-Economic Benefits

The replacement of HFCs with alternative solutions can reduce the environmental impact and increase production efficiency.

Financial Characteristics

The cost of transitioning to anti-hydrofluorocarbon technologies can vary depending on the scale of production and the type of equipment.

Transcritical CO₂ in Cold Storage:

An example is the Sagat cold storage facility in Italy, where the use of a booster system with transcritical CO₂ resulted in a 19% energy cost saving compared to R404A. The estimated payback period for the additional costs is 4.7 years, and the projected savings in operating costs over 15 years are 7.4%¹¹. This real-world example demonstrates the significant potential for energy and cost savings when using CO₂-based systems in cold storage for the agricultural sector¹².

¹¹ The Kigali Amendment to the Montreal Protocol: phased reduction in HFC consumption [in Ukrainian]. Ezra Clark, Sonya Wagner. OzonAction. <https://brgroup.com.ua/ua/a475117-kigalijska-popravka-monrealskogo.html>

¹² ATMO Europe: Transcritical CO₂ in Cold Storage Facility Offers 19% Energy Cost Savings Compared to R404A. Christina Hayes. ATMOsphere Europe. <https://brgroup.com.ua/ua/a475117-kigalijska-popravka-monrealskogo.html>

AUTONOMOUS ENERGY SUPPLY

Application Area

Agricultural crop processing

Implementation Time

Medium

Availability in the Country

Available



Photo: XOLAR

Autonomous energy supply in the processing of strawberries, raspberries, apples, and walnuts allows enterprises to reduce dependence on centralized grids and increase the environmental sustainability of production. The use of renewable energy sources (RES), such as solar, wind, and biomass, is particularly relevant.

- 1. Solar Power Plants (SPP):** Use of photovoltaic solar panels for electricity generation and solar heaters for water heating. Suitable for powering equipment for drying, cooling, sorting, and packaging products.
- 2. Wind Power Plants (WPP):** Use of wind turbines for electricity generation. Effective in areas with strong winds.
- 3. Biogas Plants:** Use of organic waste (livestock waste, processing waste, plant residues) for biogas production. Biogas can be used for electricity and heat generation.
- 4. Combined Systems:** Combination of different energy sources (e.g., solar and wind) to ensure stable energy supply. Use of battery storage to store excess energy.

Adaptation/Mitigation Benefits

Complete or partial energy supply (m)

Environmental and/or Socio-Economic Benefits

Reduction of CO₂ emissions; Reduction of livestock waste and methane utilization; Job creation (salaries, taxes).

Financial Characteristics

1. Solar Power Plants (SPP)

Capital Expenditures:

- cost of solar panels: \$500–800 per kW;
- hybrid solar power station "turnkey" (5 kW): from \$3,375;
- hybrid solar power station "turnkey" (10 kW): from \$6,500¹³.

2. Wind Power Plants (WPP)

Capital Expenditures: the cost of wind turbines depends on the capacity and manufacturer.

Operating Expenses: maintenance and repair of turbines.

3. Biogas Plants

Capital Expenditures:

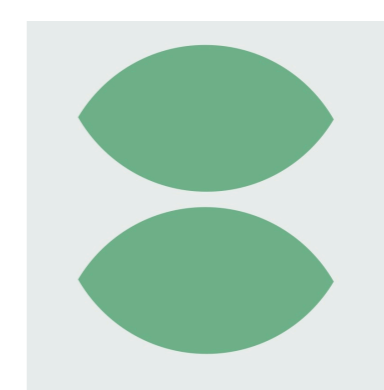
- the cost of the plant depends on the waste processing volume and capacity.

Operating Expenses:

- provision of raw materials (waste);
- equipment maintenance.

With efficient energy use, the payback period for investments in solar power stations is up to 6 years.

¹³ The cost of solar panels and power stations [in Ukrainian]. DKS SOLAR. <https://dks-solar.com.ua/prajs/>





BIOGAS

Application Area

Cultivation and processing of agricultural crops

Implementation Time

Long

Availability in the Country

Available

Photo: Dreamstime



Biogas is one of the most promising alternative energy sources in Ukraine due to the large amount of agricultural raw materials and organic production waste.

The process of biogas formation is methane fermentation, which occurs as a result of the vital activity of microorganisms. The transformation of organic waste into biogas is carried out through the process of methane fermentation of biomass under the influence of hydrolytic, acid-forming, and methane-forming bacteria¹⁴. The raw materials include waste and residues from agricultural production, manure, silage, grain waste, vegetable cuttings, straw, etc.)¹⁵.

During the operation of biogas plants, it is possible to use a gas piston cogeneration plant to obtain electricity and heat, a gas stove and a gas boiler operating on biogas¹⁶.

Adaptation/Mitigation Benefits

Full or partial autonomous energy supply (m)

Environmental and/or Socio-Economic Benefits

Reduction of methane and CO₂ emissions; job creation (salaries, taxes).

Financial Characteristics

The economic efficiency of processing organic biomass into biogas depends on many factors, including processing volumes, the cost of raw materials, production technologies, and the availability of state support¹⁷.

The state stimulates the development of biogas projects by introducing a "green" tariff for electricity generated from biogas and providing tax benefits to enterprises involved in the implementation of bioenergy projects.

The Tax Code of Ukraine provides for exemption from import VAT for equipment imported for use in the production of various types of renewable energy sources (RES).

In Ukraine, biogas plants with a fermenter volume of 2400 m³ and more, even with a payback period of 10–15 years, are capable of providing a net present value (NPV) of over UAH 0.5–7.0 million with initial investment costs of UAH 13.94 million¹⁸.

¹⁴ Biogas plants: economic viability and future prospects [in Ukrainian]. Anna Artym. AgroElita. <https://agroelita.info/biohazovi-ustanovky-ekonomichna-dotsilnist-ta-perspektyvy-na-maybutnie/>

¹⁵ A Win-Win Neighbourhood: How a grain elevator and a biomethane plant can benefit each other [in Ukrainian]. Maya Mukha. Elevatorist.com. <https://elevatorist.com/spetsproekt/194-vigidne-susidstvo-chim-mojut-buti-korisni-odne-odnomu-elevator-ta-biometanoviy-zavod>

¹⁶ Biogas: An Alternative for the Development of Ukraine's Agricultural Sector [in Ukrainian]. Yuriy Kernasyuk. Ahrobiznes sohodni. <https://agro-business.com.ua/agro/ekspertna-dumka/item/8168-biohazova-alternatyva-rozvytku-apk-ukrainy.html>

¹⁷ Biogas: An Alternative for the Development of Ukraine's Agricultural Sector [in Ukrainian]. Yuriy Kernasyuk. Ahrobiznes sohodni. <https://agro-business.com.ua/agro/ekspertna-dumka/item/8168-biohazova-alternatyva-rozvytku-apk-ukrainy.html>

¹⁸ Biogas: An Alternative for the Development of Ukraine's Agricultural Sector [in Ukrainian]. Yuriy Kernasyuk. Ahrobiznes sohodni. <https://agro-business.com.ua/agro/ekspertna-dumka/item/8168-biohazova-alternatyva-rozvytku-apk-ukrainy.html>



BIOFUELS

Application Area

Processing of agricultural crops

Implementation Time

Medium

Availability in the Country

Available



Photo: Dreamstime

Biofuels can become a profitable alternative to traditional energy resources for agro-industrial enterprises in Ukraine. In Ukraine, the development of biofuel production and use is possible in several directions:

- Production and use of diesel biofuel (biodiesel) and bio-oil: biodiesel is obtained from vegetable oils, particularly rapeseed oil. The agro-industrial technology of diesel biofuel production can meet farms' needs for their own fuel. The advantages of such production include proximity to the raw material base, increased employment of the rural population in winter, and the use of by-products (meal and glycerin sediment).
- Production of bioethanol: bioethanol is produced from fermentable sugars or starch contained in agricultural crops such as corn and sugar beet.
- Use of solid biofuels: solid biofuels such as pellets and briquettes can be made from straw, shredded wood, and other non-grain residues¹⁹. The production technology includes crushing, drying, moistening, pressing, and packaging of raw materials.

Adaptation/Mitigation Benefits

Full or partial autonomous energy supply (m)

Environmental and/or Socio-Economic Benefits

Reduction of CO₂ emissions; job creation (salaries, taxes).

Financial Characteristics

Capital Expenditures: depend on the chosen technology and production scale. Include the cost of equipment for crushing, drying, pressing, and packaging raw materials.

Operating Expenses: include costs for raw materials, electricity, labor, and equipment maintenance.

Price Range for Different Types of Biofuel:

- **Biodiesel:** from ₴41.63 per liter with orders starting from 100 tons. [All-Biz Ltd](#)
- **Bioethanol (from molasses):** offered at ₴19,180 per ton with a minimum order of 1,500 tons. [Flagma.ua](#)
- **Solid Biofuel (pellets and briquettes):**
 - Pellets: Fuel pellets 6 mm from ₴7,500 per ton. [prom.ua](#)
 - Briquettes: Peat briquettes from ₴3,360 per ton. [prom.ua](#)

¹⁹ Solid biofuels: technical requirements, component properties and production technology [in Ukrainian]. Oleg Haidenko. Ahrobiznes sohodni. <https://agro-business.com.ua/agro/idei-trendy/item/8366-tverde-biopalyvo-tekhnologichni-vymohy-vlastyvoli-komponentiv-ta-tekhnologii-vyrobnystva.html>



CARBON CREDITS

Application Area

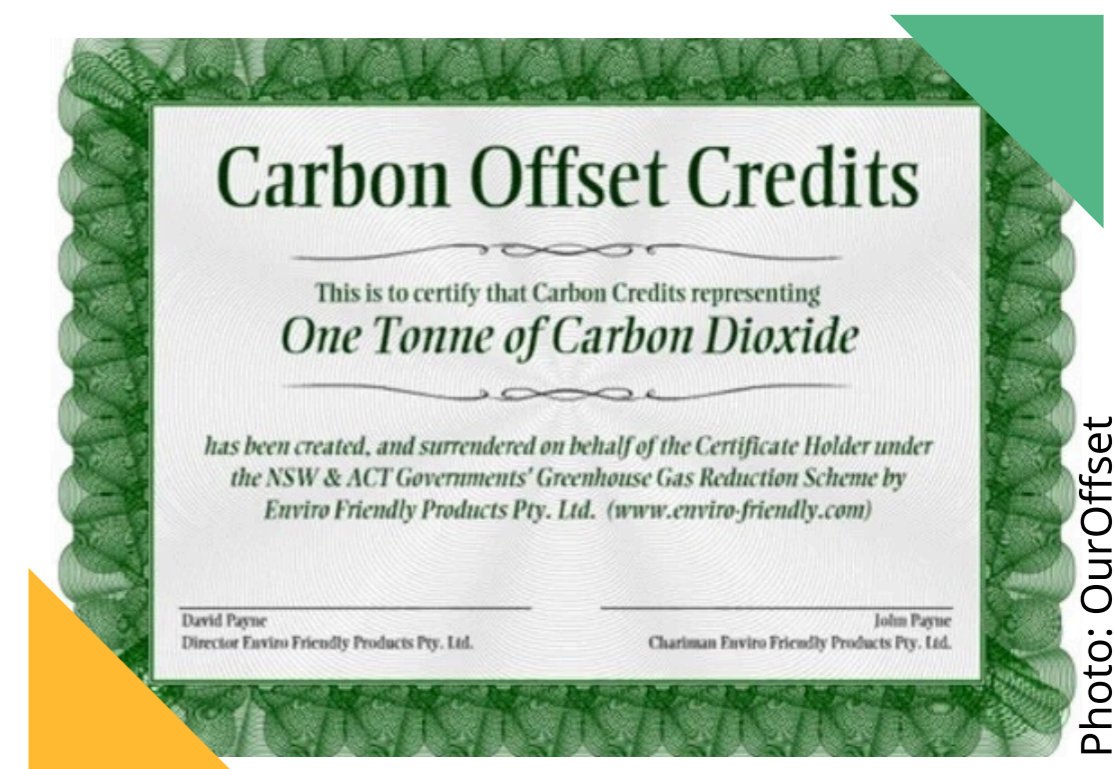
Agricultural sector, horticulture (especially apple, and walnut cultivation), and sustainable land management

Implementation Time

Medium (1-3 years)

Availability in the Country

Available



Carbon Credits (Carbon Certificates²⁰) are tradable instruments representing the reduction, avoidance, or sequestration of one metric tonne of carbon dioxide (CO₂) or its equivalent in other greenhouse gases.

By implementing regenerative practices, such as No-Till, Cover Crops, Composting, farmers can increase the carbon content in their soil. This sequestered carbon is then measured²¹, verified²² by independent auditors as carbon certificates, and issued as carbon credits that can be sold to companies seeking to offset their environmental footprint²³.

Adaptation/Mitigation Benefits

Sequestration of CO₂ in soil and biomass; reduction of N₂O emissions through precision fertilizer application. Increased soil organic matter improves water retention and resilience to droughts; enhanced soil structure protects against erosion during heavy rains.

Environmental and/or Socio-Economic Benefits

Significant improvement in soil fertility and biodiversity. Simplifies entry into EU markets by proving the low-carbon footprint of Ukrainian produce.

Financial Characteristics

Capital Expenditures: Initial soil sampling and baseline setting: €7–€24 per hectare²⁴ (depending on the project).

Operating Expenses: Annual MRV fees and platform subscriptions (10–30% of the certificate value).

Revenue Potential: Current voluntary market prices €20–€50 per certificate²⁵. Average sequestration rates in horticulture can range from 0.3 to 2.0 tonnes of CO₂ per hectare/year²⁶.

Payback Period: 3–7 years, depending on the speed of soil carbon accumulation and market price fluctuations.

²⁰ A **carbon credit** is a unit of measurement and a currency in the carbon market. One credit is equivalent to 1 tonne of CO₂ that has not been emitted into the atmosphere or has been absorbed from it. It can be bought or sold. A **carbon certificate** is a document confirming that, thanks to a specific project, a certain amount of carbon has actually been absorbed or has not been emitted into the atmosphere.

²¹ What is carbon certification? [in Ukrainian]. AGS. <https://ags.in.ua/ua/page/ags-carbon>

²² Carbon Credit Ukraine. <https://carboncreditukraine.com>

²³ Carbon credits [in Ukrainian]. AGS. <https://www.agrs.group/karbonovi-sertyfikaty>

²⁴ Carbon Credit Prices Today: Trends and Forecasts for 2026. B. de Wit. Regreener | B Corp. <https://www.regreener.earth/blog/carbon-credit-prices-today-trends-and-forecasts-for-2026>

²⁵ What Are Carbon Credits? The Complete Guide to Understanding Carbon Markets. Solartech. <https://solartechonline.com/blog/what-are-carbon-credits-complete-guide/>

²⁶ Henderson, B. et al. (2022), "Soil carbon sequestration by agriculture: Policy options", OECD Food, Agriculture and Fisheries Papers, No. 174, OECD Publishing, Paris, <https://doi.org/10.1787/63ef3841-en>.

CERTIFICATION

Application Area

Certification (strawberry, raspberry, apple, walnut)

Implementation Time

Medium/long term



Photo: Kerr Center for Sustainable Agriculture

Improving the fitness for purpose of products, processes and services, removing barriers to trade, increasing the level of satisfaction of consumer needs, additional competitive advantages compared to non-certified systems and products of competitors and, as a result, increasing the market share of raspberries, strawberries, apples and nuts by assessing compliance by an independent certification body with the requirements of international standards and certification schemes.

Scope of certification

- Organic products;
- Supply chains;
- Sustainable development, social responsibility;
- Carbon footprint;
- Food quality and safety management systems.

Standards and certification schemes taking into account the concept of sustainable development

- Legislative requirements of the European Union, the USA and Canada for organic products
- Ethical and sustainable supply chain certification schemes Sedex
- Certification schemes for sustainable development, animal welfare, human health and social responsibility KRAV, GRASP
- Sustainable Solutions for Traceable and Deforestation-Free Supply Chains, Carbon Footprint ICSS
- Forest and wood supply chain certification schemes FSC, PEFC
- Biomass Chain Certification KZR INiG

Standards and certification schemes for good agricultural practices for primary producers

- GLOBALG.AP Integrated Certification Scheme for Farmers
- Integrated certification scheme for farmers CanadaGAP
- Freshcare Food Safety & Quality Standard

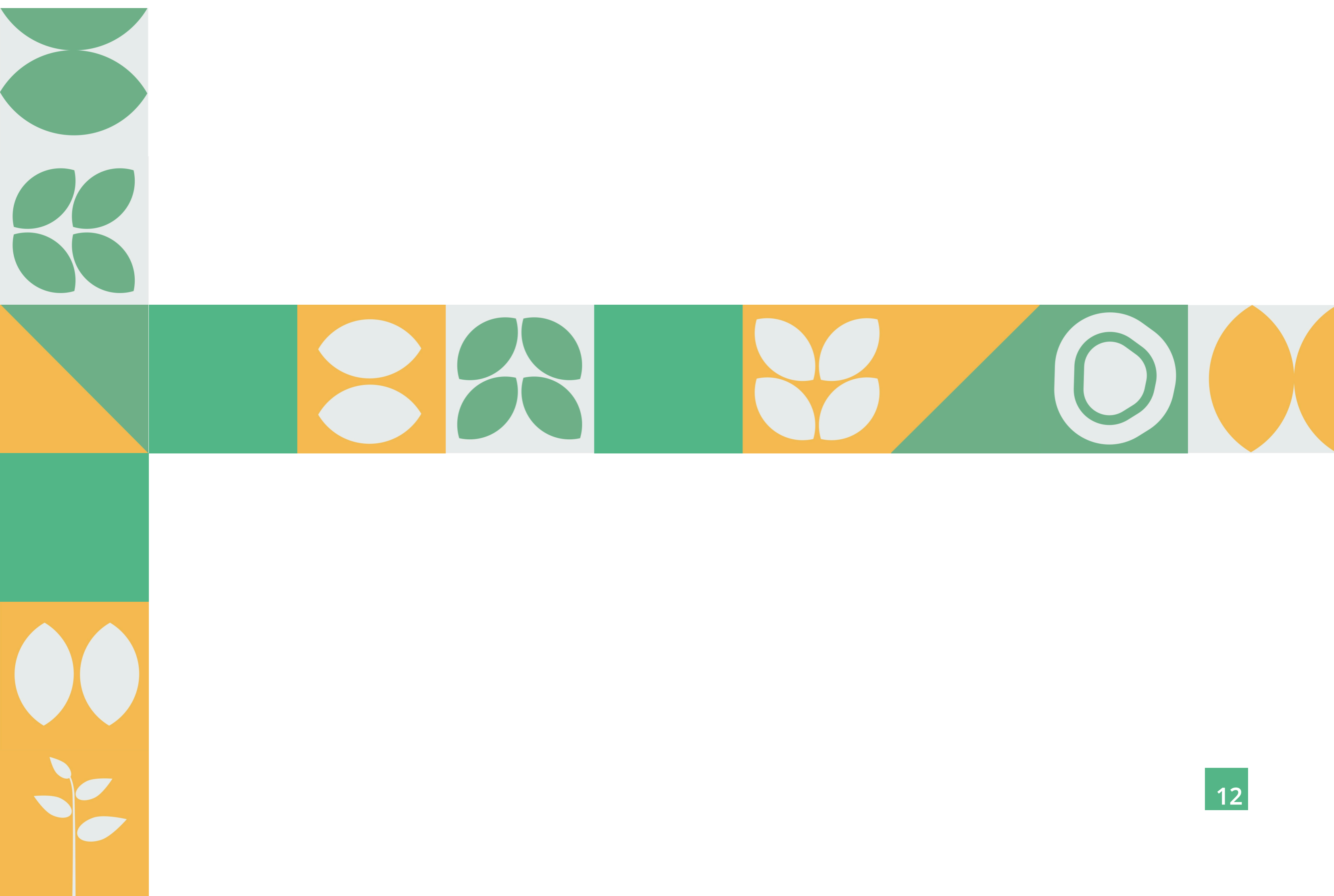
Standards and certification schemes for food quality and safety management systems

- British Retail Consortium Global Standards BRCGS Global Standard for Food Safety
- FSSC Foundation Certification Scheme FSSC 22000
- Standard of the French and German retail associations IFS Food
- Japan Food Safety Management Association Standard JFS-C Standard

Continued on the next page →

CERTIFICATION

Economic effect	The implementation of international standards and certification schemes creates opportunities to meet consumer and customer requirements, attract new partners and expand sales markets, and supply safe food products to local and global markets. At the same time, cost-effectiveness will be determined by compliance with national and international regulations, while improving food safety culture and practices.
Advantages	<ul style="list-style-type: none">• Growing consumer and customer trust in the company and products• The opportunity to cooperate with leading companies and gain long-term status as product suppliers• Availability of an effective system for managing production processes, product quality and safety
Risks	<ul style="list-style-type: none">• Costs for implementing requirements, staff training and certification• Non-compliance with the requirements of the selected standards and certification schemes and failure to obtain a certificate





COMPOSTING

Application Area

Agricultural crop cultivation (strawberry, raspberry, apple, and walnut)

Implementation Time

Short

Availability in the Country

Available

Composting is an effective method for producing organic fertilizers by recycling organic waste. In aerobic composting, oxygen is used to decompose organic substances, which ensures a fast process and high-quality compost free from pathogens and harmful microorganisms²⁷. Materials for composting include manure, straw, leaves, plant residues, and more.

Adaptation/Mitigation Benefits

Compost can be used as an organic fertilizer to improve soil fertility and protect plants from diseases²⁸(m). It improves the soil structure and enriches it with nutrients, promoting healthy tree growth²⁹ (a). Walnut tree leaves can be composted and used as fertilizer, but it is important to avoid high concentrations of juglone³⁰.

Environmental and/or Socio-Economic Benefits

Jobs (salaries, taxes)

Financial Characteristics

Composting requires significant investment: setting up a site for processing and storage, coordination with environmental services, and purchasing equipment (loaders, aerators, mixers). Initial costs are considerable — from 6 million UAH for the production of 10,000 tons of compost per year. The economic benefit lies in reducing expenses on synthetic fertilizers and increasing yields due to improved soil structure and moisture retention. High-quality compost costs about 2,000-2,500 UAH per ton, vermicompost — 4,000 UAH per ton³¹.

²⁷ Composting: effective, environmentally friendly, and beneficial for the soil [in Ukrainian]. M. Bykov. SuperAgronom. <https://superagronom.com/blog/115-kompostuvannya-efektivno-ekologichno-korisno-dlya-gruntiv>

²⁸ Walnut leaves: as garden fertiliser and for human health [in Ukrainian]. Agromarket. https://agro-market.net/ua/news/gardening/listya_gretskogo_orekha_kak_udobrenie_dlya_sada_i_polza_dlya_cheloveka/

²⁹ The environmental benefits of using compost in agriculture – protecting the environment and improving soil fertility [in Ukrainian]. Vegetable. <https://vegetable.com.ua/ekologichni-perevagi-vikoristannya-kompostu-v-silskomu-gospodarstvi>

³⁰ Walnut leaves: as garden fertiliser and for human health [in Ukrainian]. Agromarket. https://agro-market.net/ua/news/gardening/listya_gretskogo_orekha_kak_udobrenie_dlya_sada_i_polza_dlya_cheloveka/

³¹ Composting: effective, environmentally friendly, and beneficial for the soil [in Ukrainian]. M. Bykov. SuperAgronom. <https://superagronom.com/blog/115-kompostuvannya-efektivno-ekologichno-korisno-dlya-gruntiv>

COVER CROPS

Application Area

Agricultural crop cultivation (strawberry, raspberry, apple, walnut)

Implementation Time

Short

Availability in the Country

Available

Photo: extension.umaine



Cover crops are an effective adaptation measure aimed at protecting the soil from erosion, conserving moisture, and increasing its fertility.

Types of Cover Crops:

- Legumes (clover, alfalfa, vetch): Fix nitrogen and enrich the soil.
- Cereals (rye, sorghum): Suitable for weed control and improving soil structure.
- Vegetable crops (rape, radish): Used for breaking up compacted soil and weed control.

Adaptation/Mitigation Benefits

Prevention of erosion and preservation of soil structure (a); improvement of infiltration and moisture retention in the soil (a); increase in the amount of organic matter and nutrients in the soil (a); reduction in the need for herbicides and pesticides (m).

Environmental and/or Socio-Economic Benefits

The produce is free from nitrates and pesticides; job creation (salaries, taxes).

Financial Characteristics

The cost of sowing depends on the type of crop and the size of the farm. Legumes can be relatively cheap. The economic effect consists of reducing costs for fertilizers and plant protection products, increasing yields and product quality. Cover crops can pay off by increasing yields and reducing operating costs.

The cost of seeds is one of the main cost factors and varies significantly depending on the type of cover crop, seed quality and supplier. Data from the USA shows a general price range from 10 to 50 US dollars per acre (23-116 euros/ha), with individual species such as oats being cheaper and complex legume mixtures being more expensive³².

Specific examples:

- Active Soil Sugar Beet - 6 625 ₴
- Active Soil Universal (20 kg) - 5 155 ₴
- Active Soil Corn (20 kg) - 5 455 ₴

For a year of growing cover crops, you can additionally receive 3 000 UAH/ha, taking into account the amount of active substances that will come with cover crops³³.

³² Zulauf, C. and G. Schnitkey. "Policy Budget for Cover Crops and the Lesson of Crop Insurance." farmdoc daily (12):12, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, January 27, 2022. <https://farmdocdaily.illinois.edu/2022/01/policy-budget-for-cover-crops-and-the-lesson-of-crop-insurance.html>

³³ Cover crops: how much profit do they generate and how to choose them [in Ukrainian]. Y. Makovey. Kurkul.com. <https://kurkul.com/spetsproekty/1680-pokrivni-kulturi-skilki-pributku-dayut-i-yak-obrati>



CROP ROTATION

Application Area

Agricultural crop cultivation

Implementation Time

Medium

Availability in the Country

Available

Crop rotation is an important agronomic method that involves alternating different agricultural crops in the same field over several years. This approach helps preserve soil fertility, reduce the risk of pest and disease buildup, and optimize resource use³⁴.

Principles of rotation:

1. *Alternation of crops:* Different crops have varying needs for nutrients and different impacts on the soil. Proper selection of preceding crops ensures optimal conditions for the growth and development of subsequent crops³⁵.
2. *For strawberries and raspberries,* green manure crops can be used between seasons to enrich the soil with nitrogen and other nutrients.

Adaptation/Mitigation Benefits

Creation of optimal growth conditions (a); pest control (m)

Environmental and/or Socio-Economic Benefits

Jobs (salaries, taxes)

Financial Characteristics

The cost of implementing crop rotation depends on the types of crops and the scale of the farm. It does not require significant capital investment, as the main work involves planning and organizing crop rotation.

Approximate cost of consulting services for developing a crop rotation plan: 5000 UAH.



³⁴ Crop rotation: how to plan and implement it correctly for maximum yield [in Ukrainian]. Natalia Marchenko. landlord. <https://landlord.ua/agrolife-en/sivozmina-yak-pravilno-planuvati-ta-vprovadzhuвати-dlya-maksimalnogo-vrozhayu>

³⁵ Concentration and placement of crops in crop rotations [in Ukrainian]. P. Boiko, N. Kovalenko. Propozytsiya. 2015. No. 12. pp. 74–78. <https://propozitsiya.com/articles/tekhnohiiyi-vyroshchuvannya/kon-tsen-t-ratsiya-i-rozmishchen-nya-kul-tur-u-sivozminakh>

EARLY WARNING SYSTEM

Application Area

Civil protection, agricultural crop cultivation

Implementation Time

Medium

Availability in the Country

Available



A complex of technical means designed to detect threats or emergencies at an early stage of their development and to promptly notify personnel and the population in the risk zone. It includes various sensors, signaling devices, receiving and control devices, as well as sound, light, and voice notification systems. The main goal is to prevent the occurrence of an emergency or minimize its consequences through the automatic detection of dangerous parameters and the rapid informing of responsible persons and the population. For the successful cultivation of strawberries, microclimate control is important, especially temperature, humidity, and the duration of the chilling period (500-600 "chill hours" for varieties grown in Ukraine)³⁶.

An early warning system can be used to monitor climatic conditions in greenhouses or storage facilities where seedlings are kept, to avoid frost or excessive heat that affects plant development and yield³⁷.

Raspberries: Cultivation in plastic tunnels requires the control of temperature, humidity, and ventilation. An early warning system can help to detect dangerous changes in climatic conditions (e.g., overheating or sudden cooling) in a timely manner, which will allow for prompt action to save the harvest. It is also possible to monitor the status of irrigation or ventilation systems to avoid accidents³⁸.

For **apple trees**, protection from frost during the flowering period is important, as well as monitoring soil moisture and temperature for optimal growth. Early warning systems can be used to monitor weather conditions and the state of the orchard to warn of frost or excessive drought, which will help to apply protective measures such as heating or irrigation in a timely manner³⁹.

Walnut trees are particularly vulnerable to spring frosts during the flowering phase. An early warning system can record critical temperatures and other climatic threats, allowing the farmer to apply protective measures in a timely manner (e.g., covering, heating, wind protection). This is especially relevant when using super-intensive technologies, where trees have lower frost resistance and require constant microclimate control⁴⁰.

Adaptation/Mitigation Benefits

Reduction of negative environmental impact (a); help prevent crop losses due to adverse conditions by ensuring timely response to potential threats.

Continued on the next page →

³⁶ Early Warning Systems for Emergencies (EWS) [in Ukrainian]. ArtEngineering. <https://www.artengineering.com.ua/poslugi/tehnogenna-bezpeka/sistemi-rannogo-viyavlennya-nadzvichajnih-situatsij/>

³⁷ Frigo garden strawberry seedlings. FruTek. <https://www.ft.ua/frigo/>

³⁸ Growing raspberries in protected cultivation [in Ukrainian]. Agronom. <https://www.agronom.com.ua/vyroshhuvannya-malyny-v-zakrytomu-grunti/>

³⁹ How to grow an apple tree? [in Ukrainian]. Riola. <https://riola.ua/informatsiya/how-to-grow/>

⁴⁰ Principles of planting a walnut orchard [in Ukrainian]. Bohdan Malynovskyi. Propozytsiya. <https://propozitsiya.com/articles/dosvid-hospodarstv/pryntsypy-posadky-sadu-voloskykh-horikhiv>

EARLY WARNING SYSTEM

Environmental and/or Socio-Economic Benefits

Development of IT (job creation, taxes)

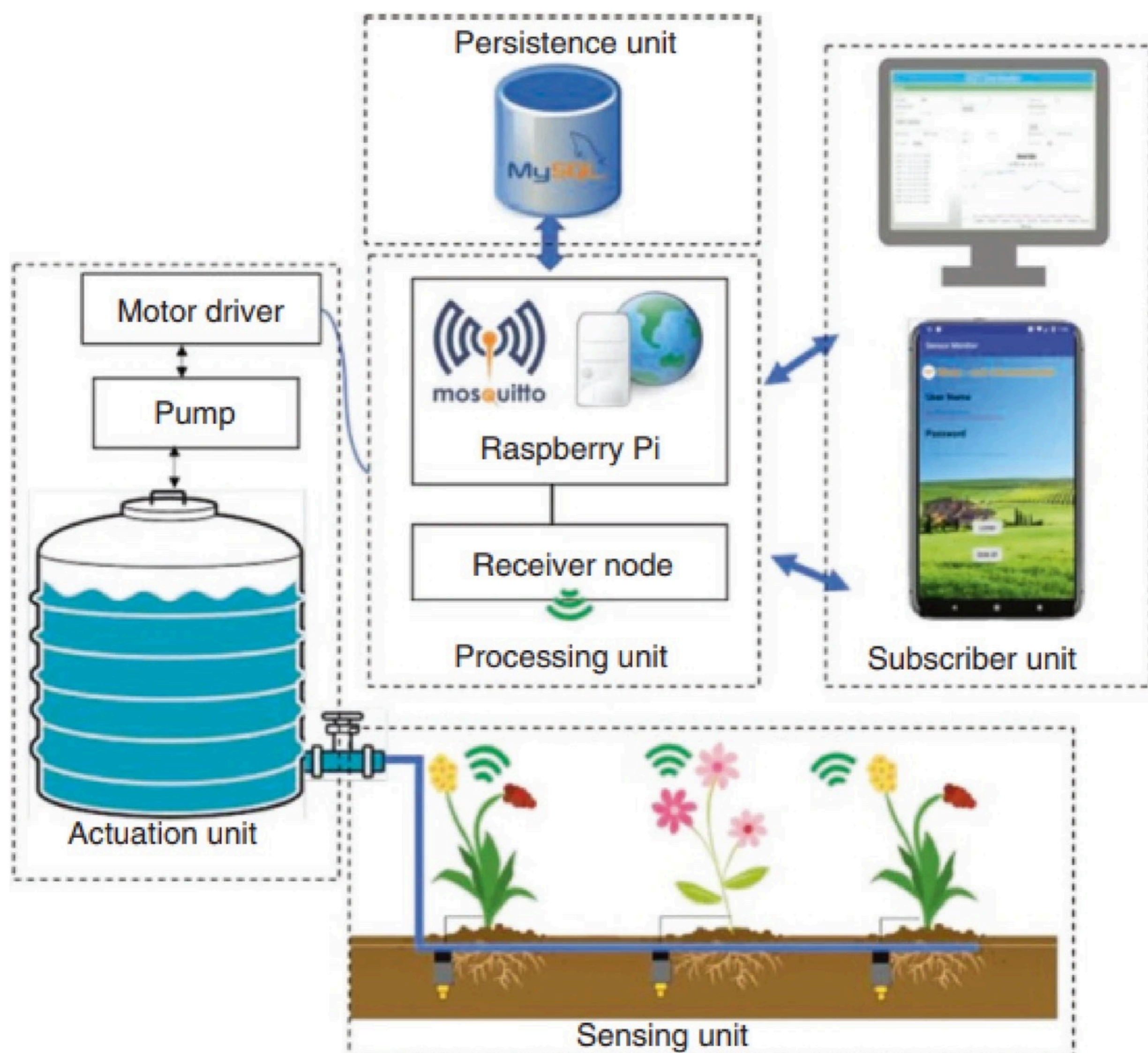
Financial Characteristics

Specific prices for early warning systems in Ukraine depend on the equipment комплектація, the scale of the facility, the type of sensors, and the level of automation. In general, such systems include:

- technological sensors (temperature, humidity, gases, motion, etc.);
- signal receiving and processing devices;
- notification means (sound, light, voice);
- centralized monitoring consoles.

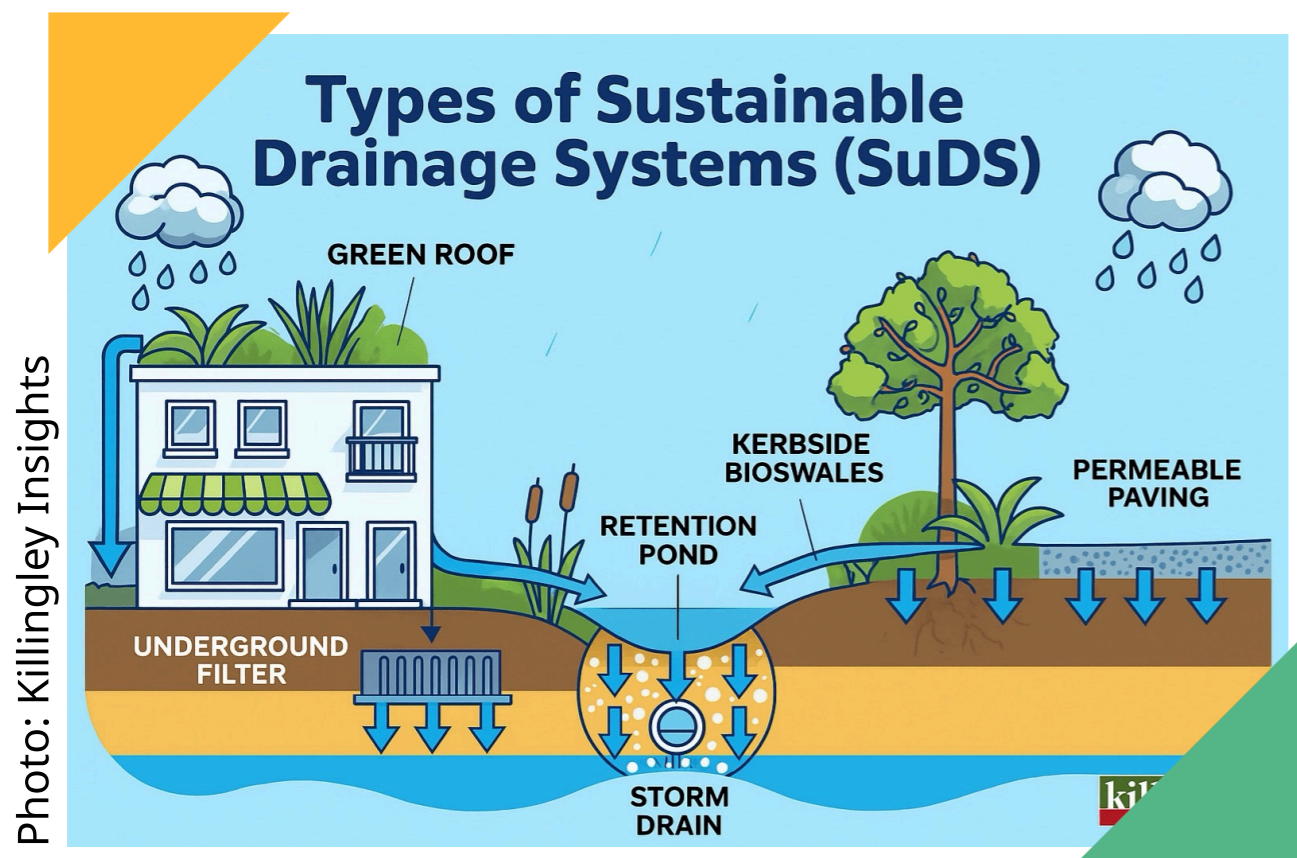
The cost can range up to hundreds of thousands of hryvnias depending on the complexity of the system. The implementation of fully automated systems with remote monitoring and integration into agronomic control is more expensive but provides the maximum level of safety and operational response⁴¹.

Photo: Intelligent and automatic irrigation system based on internet of things using fuzzy control technology



⁴¹ Early Warning Systems for Emergencies (EWS) [in Ukrainian]. ArtEngineering. <https://www.artengineering.com.ua/poslugi/tehnogenna-bezpeka/sistemi-rannogo-viyavlennya-nadzvichajnih-situatsij/>

ECO-FRIENDLY DRAINAGE SYSTEMS



Application Area

Agricultural crop cultivation

Implementation Time

Medium

Availability in the Country

Available

Eco-friendly drainage system helps maintain the optimal soil moisture level and prevent waterlogging.

System components:

1. *Drainage pipes*: perforated pipes with geotextile are used for water filtration and to prevent clogging by soil.⁴²
2. *Geotextile*: a material that does not react with aggressive environments, resistant to pests and temperature fluctuations.⁴³
3. *Crushed stone and sand*: used to create a drainage "cushion" under the pipes. The system is designed for effective drainage of rainwater and groundwater from the area.⁴⁴

Strawberries are sensitive to excessive moisture, so efficient drainage is necessary to protect the root system from rotting and to ensure optimal soil moisture. The groundwater level should be no less than 60–80 cm below the soil surface⁴⁵.

Raspberries also require good drainage to prevent soil waterlogging and black root rot, which often occurs under high moisture conditions.

Apple trees can also benefit from a drainage system, especially in areas with high groundwater levels, as it helps prevent flooding and maintain the health of the trees.

Adaptation/Mitigation Benefits

Protection of the area from flooding and preservation of soil structure (a)⁴⁶

Environmental and/or Socio-Economic Benefits

Job creation (salaries, taxes).

Financial Characteristics

The cost of the drainage system depends on the type of materials and the scale of the project. The average price for drainage of an area is approximately 450 UAH per linear meter.⁴⁷

⁴² Groundwater drainage systems [in Ukrainian]. Lyudmyla Demchuk. BudExpert. <https://budexpert.ua/content/detail/305>

⁴³ How to choose geotextiles for drainage [in Ukrainian]. Ros-Plast. <https://ros-plast.com.ua/news/kak-vybrat-geotekstil-dlya-drenazha/>

⁴⁴ Application and maintenance of drainage systems [in Ukrainian]. Voltar. <https://volar.com.ua/ua/news/primenenie-i-obslyuzhivanie-drenazhnyh-sistem.html>

⁴⁵ Garden strawberries: proper preparation and planting [in Ukrainian]. I. Storchous. Ahrobiznes sohodni. <https://agro-business.com.ua/agro/ahronomiia-sohodni/item/8903-sunytsia-sadova-pravyl-na-pidhotovka-ta-vysadzhuвання.html>

⁴⁶ Application and maintenance of drainage systems [in Ukrainian]. Voltar. <https://volar.com.ua/ua/news/primenenie-i-obslyuzhivanie-drenazhnyh-sistem.html>

⁴⁷ Turnkey site drainage [in Ukrainian]. Vash Novyy Sad. <https://www.noviy-sad.com.ua/uk/drenazh-uchastka>

ECO-FRIENDLY PACKAGING

Environmental and/or Socio-Economic Benefits

Reduction in plastic use, reduction in fossil fuel use, reduction in greenhouse gas emissions.

Financial Characteristics

Environmentally friendly materials are often more durable and can be reused multiple times, making them cost-effective in the long term⁵⁴.

1. Compostable packaging (from plant-based materials)

From 322 UAH

Packaging bags 23x30 Compost transparent roll 1/500 – 322 UAH

2. Recycled packaging (plastic that has already been used)

Linkpack: Doy-pack with a volume of 300 g — 13.20–15.50 UAH/piece. Minimum order — 1 piece

WellPacks: Garbage bags with a volume of 35 L and 60 L — 16 UAH/roll

3. Corrugated packaging (from wood and recycled corrugated materials)

Boxes — from 6.9 UAH to 45 UAH/piece

Corrugated sheets — from 18.5 UAH to 50 UAH/sheet

4. Parchment paper (from wood cellulose)

In rolls and sheets — from 27 UAH to 660 UAH depending on size and quantity

5. Kraft paper (from all types of wood)

Kraft paper bags with handles — 4.75–13.5 UAH/piece

Kraft paper bags without handles — 2.3–4 UAH/piece

6. Packaging from corn starch (from renewable sources)

Compostable packaging bags made from corn starch — from 487.50 UAH/roll

Compostable T-shirt bags made from corn starch — from 294 UAH/roll

7. Packaging from mushrooms (from mycelium)

Flower pots made from mycelium — 250 UAH

Decorative, thermal, and sound insulation panels — 800 UAH per square meter



⁵⁴ Is eco-friendly gift wrapping cost-effective? [in Ukrainian]. Rynekpapierniczy. <https://gofromagazine.com/yekologichna-upakovka-podarunkiv>

ELECTRIC TRANSPORT

Application Area

Cultivation and processing of agricultural crops

Implementation Time

Medium

Availability in the Country

Available



Photo: Sens Agro Ltd

The use of electric transport in the processing of agricultural products, storage, and transportation of processed goods ensures energy efficiency and reduces operational costs. Technological solutions for specific crops include elements of electrification.

Raspberries and Strawberries

Fluidization tunnels UNIDEX use electric systems⁵⁵: conveyor belts with adjustable speed (0.1–0.3 m/s) and vibration pulsators to prevent berries from sticking together.

Apples

Automated lines include:

- Electric conveyors for sorting and feeding raw materials.
- Optimization of costs by reducing manual labor and increasing juice yield by 15–20%⁵⁶.

Nuts

Fully automated processing lines: electric drives for conveyors (0.55 kW) and aspiration systems.

Adaptation/Mitigation Benefits

More rational use of resources (m)

Environmental and/or Socio-Economic Benefits

Increased production yield, reduced greenhouse gas emissions

Financial Characteristics

Complete processing complex for walnut (200 kg/hour) – 834,000 UAH⁵⁷

Cost of electric truck (payload 1 ton) - 99,000 EUR



⁵⁵ Freezing raspberries in UNIDEX fluidisation tunnels [in Ukrainian]. Y. Kanya, Y. Viktor. Magazine «Yahidnyk». <https://www.jagodnik.info/zamorozhuvannya-malyny-u-flyuyidyzatsijnyh-tunelyah-unidex/>

⁵⁶ Apple processing: possible options [in Ukrainian]. Y. Postolenko. Propozytsiya. <https://propozitsiya.com/articles/tehnolohiyi-zberihannya-ta-pererobka/pererobka-yabluk-mozhlyvi-varianty>

⁵⁷ Equipment for processing walnuts [in Ukrainian]. Products for poultry farming, livestock farming and beekeeping. <https://ferma24.com.ua/ua/g110776124-oborudovanie-dlya-pererabotki>



EXPORT

Application Area

Export of agricultural crops (strawberries, raspberries, apples, walnuts)

Implementation Time

Medium/long

Ensure stable and profitable exports of raspberries, strawberries, apples, and walnuts by complying with international quality standards, optimizing logistics, and concluding direct contracts with importers.

Target Products

Product	Export format	Main markets
Raspberries	Frozen (IQF)	Germany, Poland, France
Strawberries	Frozen, fresh (niche segment)	EU
Apples	Fresh (calibrated / size-graded)	EU, Middle East
Walnuts	Shelled / in-shell	EU, Turkey

Main Implementation Steps

1. Market Analysis

- Determining demand and price trends
- Selecting the target importer country
- Competitor analysis

2. Certification

- GlobalG.A.P. (for berries and apples)
- HACCP / ISO 22000 (for processing)
- Phytosanitary certificates
- Organic certification (if applicable)

3. Product Preparation

- Grading and sorting
- Implementing the cold chain
- Appropriate packaging and labeling

4. Logistics

- Contracts with carriers
- Refrigerated transport
- Customs clearance

5. Contract Conclusion

- FOB / FCA / CIF terms
- Currency settlements
- Cargo insurance

Financial Characteristics

Indices	Direct export	Through an intermediary
Selling price	Higher	Lower
Share of the producer's added value	100%	70–85%
Market control	Full	Partial
Risks	Higher	Lower

Continued on the next page →

EXPORT

Advantages	<ul style="list-style-type: none">• Access to high-paying markets• Higher selling price (15–30% above the domestic market)• Diversification of sales channels• Increased investment attractiveness of the enterprise
Risks	<ul style="list-style-type: none">• Currency fluctuations• Logistics delays• Changes in phytosanitary requirements• Competition from Poland, Serbia, and Turkey
Performance indicators	<ul style="list-style-type: none">• Share of exported products (%)• Export profitability (%)• Export revenue• Number of international contracts
Expected results	<ul style="list-style-type: none">• Export of 70–95% of frozen berries• Increase in profitability by 20–40%• Stable long-term contracts



GEODESIC DOME GREENHOUSES

Photo: Ecodome



Application Area

Agricultural crop cultivation (strawberries, raspberries)

Implementation Time

Short

Availability in the Country

Available

They allow creating an optimal microclimate for growing multiple crops throughout the year. Geodesic domes are made up of triangular elements that form a geometric

grid. Geodesic domes are 45-60% stronger than traditional greenhouses with the same coverage area and material usage. They are often used for large projects.

Various materials such as wood, steel, and fiberglass are used in the construction of geodesic domes. Due to their shape and the use of modern technologies, geodesic domes have excellent thermal insulation and energy-saving properties. This reduces heating costs.

Advantages:

- geodesic domes are resistant to winds, snow loads, and earthquakes, making them an ideal choice for construction in regions with extreme climatic conditions;
- reduction in heating and air conditioning costs due to good thermal insulation.

Disadvantages:

- installation complexity;
- more expensive than traditional structures, although their durability and energy efficiency can offset these costs in the long term;
- requires a lot of electricity.

Adaptation/Mitigation Benefits

Creates a favorable microclimate (m); protects plantings from adverse weather conditions (a).

Environmental and/or Socio-Economic Benefits

Possibility of year-round production; creation of jobs for construction and maintenance; efficient land use; support for biodiversity.

Financial Characteristics

Capital expenditures:

- 60.000-70.000 UAH (diameter 4 m²)⁵⁸
- costs for site preparation, infrastructure, and other materials: 80 thousand UAH.



⁵⁸ 'Sfera 4' dome greenhouse with 6 mm polycarbonate [in Ukrainian]. EKO TEPLYTSYA. <https://teplitca.kiev.ua/ua/p728460657-kupolnaya-teplitsa-sfera.html>

GREEN AMMONIA

Application Area

(Indirectly) Agricultural crop cultivation (as a source of nitrogen)

Implementation Time

Long

Not implemented in the country

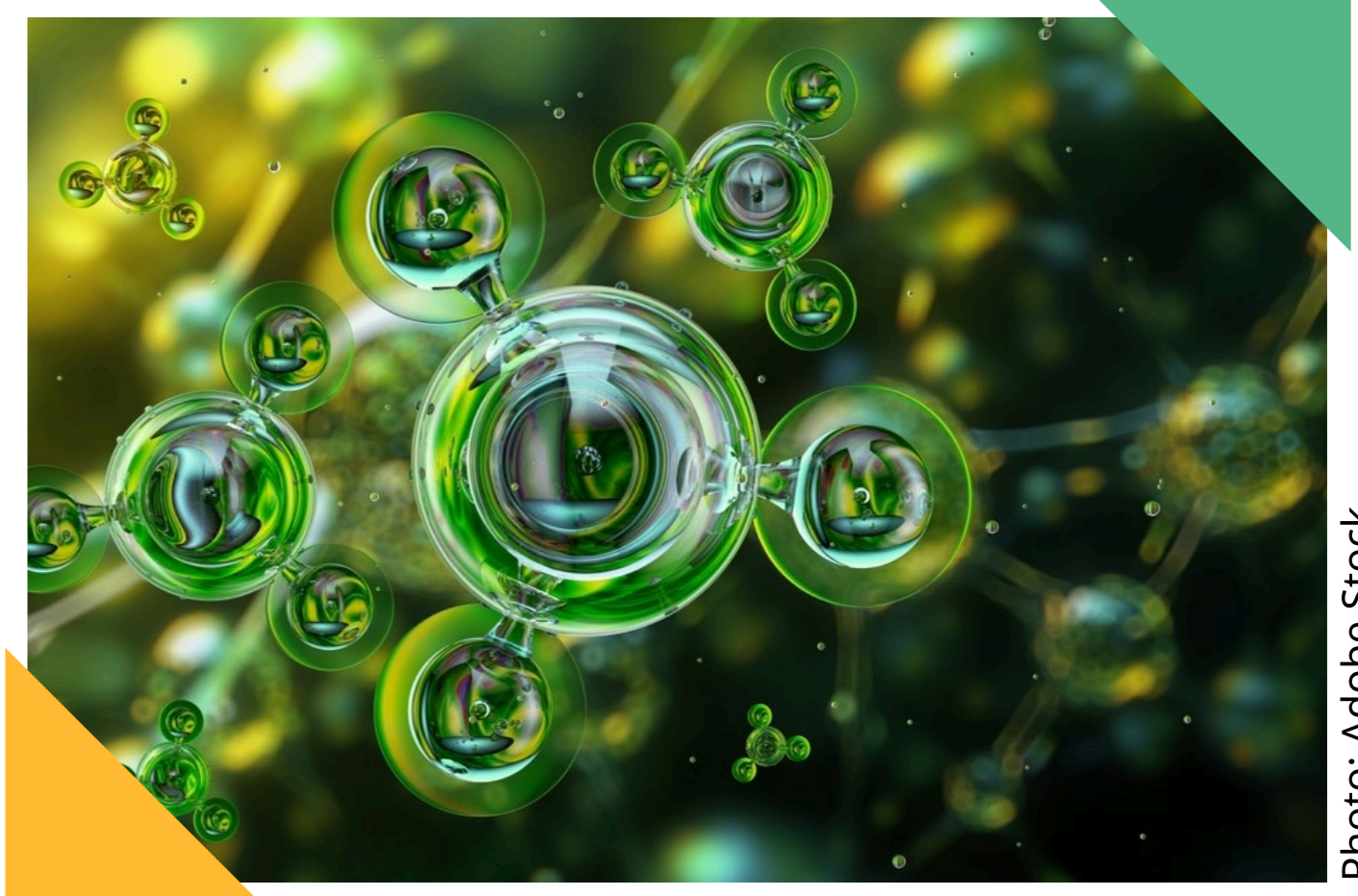


Photo: Adobe Stock

Green ammonia is a promising product produced using renewable energy sources. It is used as an alternative to conventional ammonia in the fertiliser industry, as well as an energy carrier for the transport and storage of hydrogen.

Green ammonia is produced by electrolysis of water using renewable energy sources (such as wind or solar power) to generate hydrogen. The hydrogen is then combined with nitrogen extracted from the air in the Haber synthesis process to produce ammonia⁵⁹.

Green ammonia, as a source of nitrogen fertilisers, may have an indirect bearing on the cultivation of strawberries, raspberries, apples and walnuts due to the use of nitrogen fertilisers in agriculture. Nitrogen is an essential element for plant growth and development, and green ammonia can be used as an environmentally friendly alternative to traditional nitrogen fertilisers.

Adaptation/Mitigation Benefits

Reduction in GHG emissions (m); an alternative to traditional nitrogen fertilisers (m)

Environmental and/or Socio-Economic Benefits

Job creation (salaries, taxes).

Financial Characteristics

The cost of producing green ammonia depends on the cost of renewable energy and process costs. Overall, it can be more expensive than conventional ammonia.

In 2022, the average price of green ammonia produced from hydrogen in Europe was €952 per tonne.

The initial base price of the green ammonia production system (in Canada) is 950,000 Canadian dollars (655,000 euros). However, the actual price paid by each customer will vary depending on the specific characteristics of their farm. These characteristics include access to 'green' electricity, the size and configuration of the optimal production system, and the number of systems (one or more).

⁵⁹ The Royal Society (2020) Ammonia: Zero-Carbon Fertiliser, Fuel and Energy Store. Policy Briefing, The Royal Society, London. <https://royalsociety.org/-/media/policy/projects/green-ammonia/green-ammonia-policy-briefing.pdf>

HAIL AND BIRD NETS

Photo: Agronomist



Application Area

Agricultural crop cultivation (strawberries, raspberries, apples, walnuts)

Implementation Time

Short

Availability in the Country

Available⁶⁰

Hail and bird nets are used to protect agricultural crops from damage caused by hail and pests such as birds. Hail nets are made from polyethylene monofilament using a special weaving technology, which ensures increased strength and wear resistance. They protect crops from hail and wind damage. Bird nets are made from an ultra-light polymer and have an optimally selected mesh size that allows light and air to pass through while preventing birds from accessing fruits and berries.

Adaptation/Mitigation Benefits

Protects against adverse environmental conditions (a)

Environmental and/or Socio-Economic Benefits

Jobs (taxes, salaries)

Financial Characteristics

The cost of hail protection nets depends on their size and material type. For example, the Tenax Defender net is available in rolls ranging from 2×100 to 8×100 meters. The price of a 3×10 meter shading net is approximately 1,467.57 UAH.

⁶⁰ Bradas BIRD NET bird protection netting, 19×19 mm, 2×10 m [in Ukrainian]. Agronomist. https://agronomist.vn.ua/sadovisitky/sitky-dlia-zakhystu-vid-ptakhiv/zakhysna-sitka-vid-ptakhiv-bradas-19-19-mm-2-10-m?gad_source=1&gclid=Cj0KCQjw1um-BhDtARIsABjU5x6rdIgbjDaEI0fJjTpfKa72bhujTFvhf5-yoosJ50SMExy8Jfx9AJ4aApuqEALw_wcB

HAIL AND RAIN PROTECTION WRAPS

Application Area

Agricultural crop cultivation
(garden strawberry, raspberry, apple, walnut).

Implementation Time

Short

Availability in the Country

Available



Special polyethylene or multilayer film systems are stretched over orchards, berry plantations, or individual plants to provide protection against hail, heavy rain, wind, birds, and insects.

Modern systems often integrate the film with netting, which offers comprehensive orchard protection. The film is attached to cables above the rows, secured with specialized clamps, and can be quickly rolled up for winter or as needed. To ensure structural stability, additional cables and anchors are used to withstand wind gusts and the weight of precipitation.

The film reduces risks of plant damage from spring frosts. It retains heat around the plants, lowers wind intensity, allows the use of supplementary heating methods (smoke, burners), and can increase the temperature under the cover by 2–3°C—crucial for preserving buds and fruit set.

Adaptation/Mitigation Benefits

Protects against adverse environmental conditions (a)

Environmental and/or Socio-Economic Benefits

Jobs (salaries, taxes)

Financial Characteristics

The cost of films varies depending on the type and quality of materials. The price also depends on the film's quality and size, but generally it may range from several thousand to tens of thousands of hryvnias for large areas. Greenhouse film (often also used for orchard coverings) with a thickness of 80–150 μm costs 1,680–4,200 UAH per roll (width 1.5–3 m, length 50–100 m)⁶¹.

For large orchards, the total system cost with installation is much higher, as it includes cables, anchors, and labor.



⁶¹ Plastic films [in Ukrainian]. Nika Plast. <https://nika-plast.od.ua/uk/category/teplychni-plivky/>

HYDROPONICS

Application Area

Agricultural crop cultivation (strawberry)

Implementation Time

Medium

Availability in the Country

Available⁶²



Photo: Sun Life Hydroponics

An innovative technology for growing plants without soil, where plants feed through their roots in a moist-air environment or on a solid porous substrate, receiving nutrients from a nutrient solution⁶³. It allows controlling the growing conditions of plants, providing optimal nutrition, temperature, lighting, and humidity⁶⁴. In Ukraine, there is experience in growing garden strawberries using hydroponics⁶⁵.

Hydroponic methods:

1. *Drip irrigation*. Постійне або періодичне подання живильного розчину до коренів рослин через крапельниці⁶⁶.
2. *Nutrient Film Technique (NFT)*. The plant roots are placed in a narrow tube with a continuously circulating nutrient solution⁶⁷.
3. *Ebb and Flow Systems*. The nutrient solution periodically flows to the plant roots, providing access to oxygen⁶⁸.
4. *Floating Platform (DWC)*. Plants are placed on floating platforms in a reservoir with nutrient solution⁶⁹.

Adaptation/Mitigation Benefits

Up to 90% water savings due to the closed-loop nutrient solution cycle (a); Resistance to adverse weather conditions (a), Nutrient savings (a, m); mechanization (no need for tractors and large machinery) (m); reduced need for herbicides and pesticides (no weeds and pests) (a, m)⁷⁰

Environmental and/or Socio-Economic Benefits

Space savings, job creation (salaries, taxes).

Continued on the next page →



⁶² A unique experience: hydroponic strawberries. The case of FOP "Hutsol" [in Ukrainian]. Bohdan Malynovskyi. Propozitsiya. <https://propozitsiya.com/articles/dosvid-hospodarstv/unikalnyy-dosvid-sunytsya-na-hidroponitsi-keys-fop-hutsol>

⁶³ Hydroponics [in Ukrainian]. Oleksandr Steletskyi. FloraGrowing.com. <https://floragrowing.com/uk/encyclopedia/gydroponyka>

⁶⁴ Hydroponics: what is this method and why do farmers need it [in Ukrainian]. Yaroslav Smakota. AgroApp. <https://agroapp.com.ua/uk/blog/gidroponika-shho-ce-za-metod-i-dlya-chogo-potriben-fermeru/>

⁶⁵ A unique experience: hydroponic strawberries. The case of FOP "Hutsol" [in Ukrainian]. Bohdan Malynovskyi. Propozitsiya. <https://propozitsiya.com/articles/dosvid-hospodarstv/unikalnyy-dosvid-sunytsya-na-hidroponitsi-keys-fop-hutsol>

⁶⁶ Hydroponics [in Ukrainian]. Oleksandr Steletskyi. FloraGrowing.com. <https://floragrowing.com/uk/encyclopedia/gydroponyka>

⁶⁷ Hydroponics [in Ukrainian]. Oleksandr Steletskyi. FloraGrowing.com. <https://floragrowing.com/uk/encyclopedia/gydroponyka>

⁶⁸ How to grow plants using hydroponics [in Ukrainian]. Part I. GrowPro. <https://growpro.ua/ua/articles/detail/yak-pravilno-viroshchuvati-gidroponiku-chastina-i/>

⁶⁹ Hydroponics: what is this method and why do farmers need it [in Ukrainian]. Yaroslav Smakota. AgroApp. <https://agroapp.com.ua/uk/blog/gidroponika-shho-ce-za-metod-i-dlya-chogo-potriben-fermeru/>

⁷⁰ Hydroponics: what it is and its prospects for development in Ukraine [in Ukrainian]. Bohdan Kruglyk. WEAGRO. <https://weagro.ua/blog/gidroponika-shho-cze-perspektyvy-rozvytku-v-ukrayini/>

HYDROPONICS

Financial Characteristics

Hydroponic systems can be expensive, especially large-scale projects, and require a lot of electricity⁷¹. Due to water savings and increased yields, hydroponics can provide a faster return on investment. Yields can be 30–50% higher compared to traditional farming⁷². Hydroponic systems for growing berry crops, such as strawberries and others, cost from 1300 UAH⁷³. According to a business plan developed by experts for a greenhouse complex for growing garden strawberries using a hydroponic system with an area of 1 hectare, the construction will cost approximately 3.2 million USD.

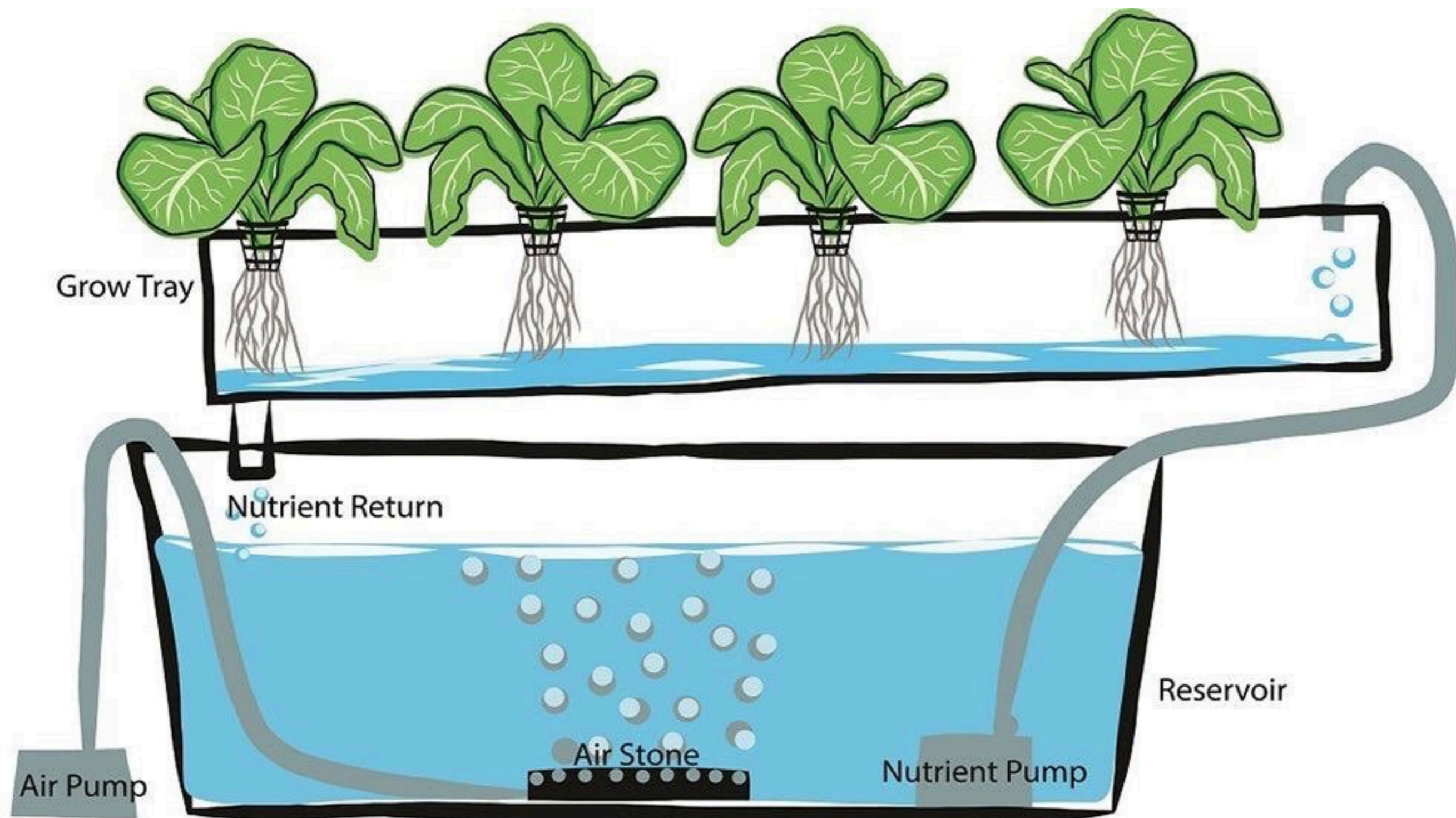


Photo: LetPotTeam



⁷¹ The pros and cons of hydroponic growing [in Ukrainian]. Grow.in.ua. <https://grow.in.ua/uk/blog/technology/plyusy-i-minusy-gidroponnogo-vyrashchivaniya>

⁷² Hydroponics: what it is and its prospects for development in Ukraine [in Ukrainian]. Bohdan Kruglyk. WEAGRO. <https://weagro.ua/blog/gidroponika-shho-cze-perspektyvy-rozvytku-v-ukrayini/>

⁷³ AutoPot – an automatic hydroponic system [in Ukrainian]. Hydroponics. <https://hydroponics.in.ua/ua/sistemy-i-poliv/tovtree-autopot/>

MARKETING

Application Area

Marketing of agricultural cultures
(strawberries, raspberries, apples, walnuts)

Implementation Time

Short/long



Photo: ekapol/iStock

Increasing the competitiveness of raspberries, strawberries, apples and nuts by creating a recognisable brand, expanding sales channels and generating added value through marketing tools.

Target products

- Wholesale buyers and traders
- Processing enterprises
- Retail (national and local chains)
- Importers (EU)
- Final consumers (for fresh products)

Key elements of marketing practice

1. Branding

- Logo and corporate identity development
- Creation of a unique selling proposition
- Eco-friendly or organic positioning

2. Packaging and labelling

- Information about product origin
- Compliance with EU requirements
- Modern packaging design

3. Promotion channels

- Social networks (Facebook, Instagram, LinkedIn)
- Company website
- Online marketplaces
- Participation in exhibitions (Fruit Logistica, SIAL, etc.)

4. Pricing strategy

- Price differentiation depending on the segment
- Premium strategy for certified products
- Flexibility when working with large contracts

Economic effect

Indicator	Before implementation	After implementation
Average selling price	100%	+15–30%
Share of regular customers	Low	High
Brand awareness	Minimal	Stable

Continued on the next page →



MARKETING

Advantages	<ul style="list-style-type: none">• Increased added value of products• Ability to sell at a premium price• Formation of long-term contracts• Increased buyer confidence
Risks	<ul style="list-style-type: none">• Brand development and advertising costs• Packaging not meeting importer requirements• Insufficient product volume to support the brand
Performance metrics	<ul style="list-style-type: none">• Sales price growth (%)• Sales volume (tonnes)• Number of new customers• Share of exports in sales structure• Repeat order rate
Expected results	<ul style="list-style-type: none">• Increase in profitability by 20–35%• Increase in export share• Creation of a recognisable brand for Ukrainian products



MULCHING

Application Area

Agricultural crop cultivation (strawberries, raspberries)

Implementation Time

Short

Availability in the Country

Available



Photo: The Homesteading RD

The technology involves covering the soil surface with a layer of organic materials, such as straw, fallen leaves, or compost.

It includes the following stages:

1. *Mulch preparation*: using shredded plant residues, straw, compost, etc;
2. *Mulch application*: spreading the mulch over the soil surface with a thickness of 5–10 cm;
3. *Mulch decomposition*: the process of mulch decomposition promotes soil humification, improves its structure, and increases the content of organic matter.

Adaptation/Mitigation Benefits

Retains moisture in the soil (a); reduces the need for herbicides and pesticides (suppresses weed growth) (m); decomposition of mulch increases humus content, improves aeration and soil structure (a).

Environmental and/or Socio-Economic Benefits

Produce is clean from herbicides; resource savings (reduces berry rot and improves soil structure); jobs (salaries, taxes).

Financial Characteristics

The cost of mulch depends on the type of materials, but often available local resources (straw, fallen leaves) are used. Mulching pays for itself due to increased yields and reduced costs for agricultural practices. Mulching increases yields by 20–25% due to better nutrient utilization by plants⁷⁴.

Mulching service price: from 41.53 UAH/hectare

Mulching with bark, wood chips (without material cost) – 40 UAH/m²

KyivBudService: Provides mulching services in the Boryspil district of the Kyiv region using a Bobcat mulcher. The cost is 24,800 UAH per shift (8 hours), which is equivalent to 3,100 UAH per hour

⁷⁴ Mulching as a means of improving soil physical properties and the effectiveness of mineral nutrition in agricultural crops [in Ukrainian]. V. Medvedev, T. Lindina. Ministry of Agrarian Policy of Ukraine. <http://www.minagro.kiev.ua/page/?1987>

NETS + FILMS

Application Area

Agricultural crop cultivation
(strawberry, raspberry, apple, walnut)

Implementation Time

Short

Availability in the Country

Available



Photo: Kurkul.com

Nets and films help protect plants from adverse weather conditions and provide an optimal microclimate for their growth.

Some nets can shade the plant, providing protection from sunlight, reducing temperature (by 10 degrees), and evenly distributing light. Nets can protect plants from large hail, which can cause significant damage to crops. Used to protect plants from direct sun, wind, rain, and hail. Suitable for open land and greenhouses.

Films. Greenhouse film creates a warm microclimate, accelerates plant growth, and protects the soil from mold and weeds. Used in film tunnels to protect plants from adverse weather conditions and ensure high-quality yields.

Adaptation/Mitigation Benefits

Protects from adverse environmental conditions (a)

Environmental and/or Socio-Economic Benefits

Jobs (salaries, taxes)

Financial Characteristics

The cost of nets and films varies depending on the type and quality of materials. Shading nets can cost from several hundred to thousands of hryvnias per unit, depending on the size and degree of shading. Greenhouse film also depends on quality and size, but generally, it can cost from several thousand to tens of thousands of hryvnias for large areas.



NO-TILL

Photo: NRCS



Application Area

Agricultural crop cultivation
(strawberries, raspberries)

Implementation Time

Medium

Availability in the Country

Available⁷⁵

A modern farming system that involves the abandonment of traditional plowing of the soil. Special seeders cause minimal disruption to the soil surface, only in the areas where seeds are sown. Mulch may be used. The soil surface is constantly covered with a layer of shredded plant residues (mulch), which protect the soil from erosion, retain moisture, and gradually transform into organic fertilizers⁷⁶.

Adaptation/Mitigation Benefits

The No-Till method ensures significant resource savings (m), helps preserve soil moisture (a), prevents soil erosion (a), and improves soil fertility (a)

Environmental and/or Socio-Economic Benefits

Jobs (salaries, taxes)

Financial Characteristics

The cost of implementing the no-till technology depends on the specialized equipment required for direct seeding. Special seeders can cost from several tens of thousands to hundreds of thousands of hryvnias, depending on the type and quality. Savings are achieved by reducing fuel, equipment, and labor costs.

Examples of equipment and their costs:

- Pneumatic grain seeder Remsintez SICH-6 Pro No-Till - 1,265,000 UAH
- Used pneumatic seeder John Deere 1750 with 8 rows and No-Till system - 35,000\$



⁷⁵ No-till farming: what it is and its prospects in Ukraine [in Ukrainian]. Bohdan Kruglyk. WEAGRO. <https://weagro.ua/blog/no-till-tehnologiyi-shho-cze-perspektyvy-v-ukrayini/>

⁷⁶ M. Dykun. Intensive cultivation techniques for garden strawberries and raspberries in open fields. Kyiv. «Khvylya». 2009. https://dorada.org.ua/storage/docs/Бібліотека%20дорадника/Рослинництво/NAAASU-Dykun_book_about_strawberry.pdf

ORGANIC FERTILISERS AND PLANT PROTECTION PRODUCTS

Application Area

Agricultural crop cultivation
(strawberries, raspberries, apples, walnuts)

Implementation Time

Short

Availability in the Country

Available^{77 78 79 80}



Photo: Africa Studio

Biological fertilizers and plant protection products are important tools for enhancing the efficiency and environmental sustainability of agriculture in Ukraine. These products use microorganisms and other natural components to improve soil fertility and protect plants from diseases and pests. Biological fertilizers are made from microorganisms that fix nitrogen, mobilize phosphorus and other nutrients, improving soil structure and increasing yields. Biological plant protection products use microorganisms and other natural components to combat plant diseases and pests without harming the environment.

Bacterial preparations: nitrogen-fixing bacteria, phosphorus-mobilizing bacteria. Fungal preparations: Trichodermin, Mycohelp. Insecticides: Bitoxibacillin, Lepidocide.

- 1. Strawberries and raspberries:** biological protection products can be used to protect against diseases and pests during flowering and fruit ripening.
- 2. Apples:** biological fertilizers can be applied to enhance soil fertility and protect apple trees from diseases.
- 3. Walnuts:** biological products can be useful for protecting young trees from pests and diseases.

Adaptation/Mitigation Benefits

Increase in the amount of organic matter and nutrients in the soil (a); reduction in the need for herbicides and pesticides (m)

Environmental and/or Socio-Economic Benefits

The products are environmentally friendly; jobs are created (salaries, taxes).

Continued on the next page →



⁷⁷ New approaches to the use of biological products in berry plantations [in Ukrainian]. Volodymyr Silenko. Zhurnal "Yahidnyk". <http://www.jagodnik.info/novi-pidhody-do-zastosuvannya-biopreparativ-u-yagidnyh-nasadzhennyah/>

⁷⁸ Innovative technologies for the production of organic fertilisers – new opportunities for agriculture [in Ukrainian]. Vegetable. <https://vegetable.com.ua/innovatsijni-texnologii-virobnitstva-biologichnix-dobriv-novi-mozhливosti-dlya-sil'skogo-gospodarstva/>

⁷⁹ Biological plant protection products [in Ukrainian]. Agroexpert Trade. <https://agroexp.com.ua/uk/biologicheskie-sredstva-zashchity-rasteniy>

⁸⁰ The state and challenges of the market for biological plant protection products in Ukraine [in Ukrainian]. V.I. Krutyakova, O.I. Gulich, L.A. Yanse. Bulletin of Agricultural Science. 2023, No. 1 (838), 30–39. https://agroviznyk.com/pdf/ua_2023_01_04.pdf

ORGANIC FERTILISERS AND PLANT PROTECTION PRODUCTS

Financial Characteristics

The cost of biological fertilizers and plant protection products depends on the type of product and the scale of the farm. These products can be cheaper than chemical alternatives in the long term.

1. List of biological fertilizers suitable for **strawberries** and their prices in various online stores:

- **Baikal EM-1-U biofertilizer for strawberries (Vse Roste):** 25 UAH (40 ml)
Specially developed for these crops, likely promoting their growth and yield.
- **Organic fertilizer for strawberries Kvitofor Stimul Natural (Agrovinn):** 30.00 UAH (310 ml) An organic fertilizer designed to stimulate strawberry growth and fruiting.
- **Organic fertilizer STIMUL NATURAL for strawberries (Dobrodar):** UAH (310 ml), 38.83 UAH (550 ml)
- **Humate 100 fertilizer, Smart Eco Organic (Vse Roste):** 130 UAH (500 ml), 228 UAH (1l) Humic acid-based fertilizers usually improve soil structure and nutrient absorption, positively affecting strawberry growth.

2. List of biological fertilizers suitable for **raspberries** and their prices in various online stores:

- **Baikal EM-1-U biofertilizer for raspberries, blackberries, currants (Vse Roste):** 25 UAH (40 ml)
- **Vermisol (Agrovinn):** 170.00 UAH (5 l), 25.00 UAH (0.25 l)
- **Humate 100**

3. List of biological fertilizers suitable for **apple trees** and their prices:

- **BioNPK fertilizer (Vse Roste):** 72 UAH
- **Vermisol and Humate 100**

4. List of biological fertilizers suitable for **walnut trees** and their prices: **Vermisol, Humate 100, BioNPK**



PEST-RESISTANT CROPS

Application Area

Agricultural crop cultivation

Implementation Time

Medium

Availability in the Country

Available



Photo: Shutterstock

Crops resistant to diseases and pests are an important direction in modern agriculture in Ukraine. Using such crops helps reduce the use of chemical plant protection products and increases the resilience of agriculture to diseases and pests.

Principles of use:

1. *Genetic resistance*: Selecting plant varieties with natural resistance to certain diseases and pests.
2. *Breeding work*: Developing new varieties with increased resistance to diseases and pests through selection and hybridization.
3. *Strawberries and raspberries*: Using varieties with increased resistance to diseases such as powdery mildew or rust helps reduce the use of chemical plant protection products.
4. *Apples*: Apple varieties with increased resistance to diseases like scab or sooty mold can help reduce the risk of diseases.
5. *Walnuts*: Using walnut varieties with increased resistance to diseases such as anthracnose or root rot can help reduce the risk of diseases.

Adaptation/Mitigation Benefits

Creating optimal conditions for growth (a); combating diseases (a)

Environmental and/or Socio-Economic Benefits

Job creation (salaries, taxes)

Financial Characteristics

The cost of implementing crops resistant to diseases and pests depends on the type of crop and the scale of the farm. It requires capital expenditures for purchasing new crops, while the main work involves selecting and growing the appropriate varieties.

1. Strawberry:

- **Roxana®**: mid-late variety with high yield. Tolerant to powdery mildew and other diseases. From €0.21 per seedling.
- **Allegro**: strawberry variety resistant to fungal diseases, such as Phytophthora, Verticillium, and powdery mildew. 139 UAH for 3 seedlings.

2. Raspberry:

- **Sugana**: everbearing variety with high yield and disease resistance. Price: 98 UAH for 2 seedlings.
- **Cascade Delight**: variety with high yield and resistance to root diseases. Price: 36 UAH per seedling.
- **Caramelka**: everbearing variety with high yield and disease resistance. Price: 67.41 UAH per seedling.

Continued on the next page →

PEST-RESISTANT CROPS

3. Apple Tree:

- **Florina**: Variety with high immunity to scab, monilia, powdery mildew, bacterial burns, and aphids. Price: 130 UAH per tree.
- **Liberty**: Variety resistant to scab and powdery mildew. Price: 80 UAH per tree.

4. Walnut:

- **Ideal**: Resistant to Marsonia and chlorosis. Price: 70 UAH per tree.
- **Giant**: Has increased immunity to pathogens. Drought-resistant, can easily withstand severe frost. Price: 140 UAH per tree.



Photo: Agro-Market™



PRECISION AND DRIP IRRIGATION

Application Area

Agricultural crop cultivation (strawberries, raspberries, apples, walnuts)

Implementation Time

Medium

Availability in the Country

Available



Photo: Pipelife

Modern technologies that optimize the use of water resources in agriculture, providing precise water delivery directly to the root zone of plants.

1. Drip irrigation.

Involves the use of special drip emitters that deliver water directly to the root system of plants in the required amount and at the right time. This minimizes water losses due to evaporation and runoff, increasing the efficiency of water resource use by up to 95%⁸¹.

2. Precision irrigation.

Includes the use of various technologies to accurately determine the water needs of plants. Precision irrigation often utilizes soil moisture sensors and weather stations to optimize the irrigation process⁸².

Advantages

Increased yield: precision and drip irrigation provide the optimal soil moisture level, which promotes better plant growth and higher yields.

Reduced disease risk: water is delivered directly to the root zone, reducing the risk of diseases related to excessive moisture on the leaves.

Adaptation/Mitigation Benefits

Water savings (a, m): Drip irrigation allows for more efficient water use, reducing losses due to evaporation and runoff.

Environmental and/or Socio-Economic Benefits

The possibility of growing crops, including as a type of economic activity (jobs, taxes)

Financial Characteristics

Capital expenses: medium. The cost of a drip irrigation system for an average farm ranges from 50,000 to 200,000 UAH, depending on the scale of the project.

Operational expenses: Operational expenses include costs for system maintenance, replacing drippers, and energy for operating pumps. These costs are usually lower compared to traditional irrigation methods due to more efficient water usage.

The typical payback period for such systems is 2-5 years.

⁸¹ Land under the 'drip': life-giving irrigation [in Ukrainian]. V. Borzenko. Ahrobiznes sohodni. <https://agro-business.com.ua/agro/mekhanizatsiia-apk/item/1233-zemlia-pid-krapelnytseiu-zhyttiedaine-zroshennia.html>

⁸² Field Irrigation: A Modern Approach to Agriculture [in Ukrainian]. K. Sergeeva. EOS Data Analytics. <https://eos.com/uk/blog/zroshennia-poliv/>

PRECISION FARMING



Photo: Traktorist.ua



Application Area

Agricultural crop cultivation (strawberry, raspberry; apple, walnut – only for seedling protection)

Implementation Time

Medium

Availability in the Country

Available^{83 84}

This approach involves the use of advanced technologies to optimize cultivation and increase agricultural efficiency.

Application of precision farming for **raspberry** and **strawberry**:

1. *Plant condition monitoring*: Using IoT sensors to monitor soil and plant health, allowing for optimized fertilization and plant protection.
2. *Irrigation optimization*: Utilizing precision irrigation systems, such as drip irrigation, to reduce water consumption and increase irrigation efficiency.
3. *Data analysis*: Employing data analytics to determine optimal growing conditions and increase yields.

Application of precision agriculture for **apple** and **walnut**:

1. *Tree condition monitoring*: Using sensors to monitor tree and soil health, allowing for optimized tree care and protection.
2. *Fertilizer application optimization*: Utilizing precision systems for fertilizer application, reducing costs and increasing resource use efficiency.
3. *Data analysis*: Employing satellite data to monitor orchard conditions and optimize tree growth conditions.

Adaptation/Mitigation Benefits

Creation of optimal growing conditions (a); optimization of fertilizer application (m); reduction of GHG emissions (m).

Environmental and/or Socio-Economic Benefits

Jobs (salaries, taxes); development of IoT and related sectors (IT, engineering, mechanical engineering).

Financial Characteristics

The cost of implementing precision agriculture systems is estimated by consulting firms, as it depends on the level of automation. Savings of up to 7% on fertilizers, up to 9% on pesticides and herbicides, and up to 6% on fuel, 4% on water⁸⁵.

Implementing a basic level of precision agriculture may require an investment of around \$40,000, depending on the available equipment and the size of the farm.

⁸³ Precision Farming in Ukraine: Definition and Prospects [in Ukrainian]. Bohdan Kruglyk. WEAGRO. <https://weagro.ua/blog/tochne-zemlerobstvo-v-ukrayini-vyznachennya-ta-perspektyvy/>

⁸⁴ A guide to precision farming has been produced in Ukraine [in Ukrainian]. Traktorist.ua. <https://traktorist.ua/news/v-ukrayini-stvorili-posibnik-z-tochnogo-zemlerobstva>

⁸⁵ Precision Farming in Ukraine: Definition and Prospects [in Ukrainian]. Bohdan Kruglyk. WEAGRO. <https://weagro.ua/blog/tochne-zemlerobstvo-v-ukrayini-vyznachennya-ta-perspektyvy/>

PRECISION FERTILIZER APPLICATION

Application Area

Agricultural crop cultivation (strawberry, raspberry; apple, walnut).

Implementation Time

Medium

Availability in the Country

Available⁸⁶

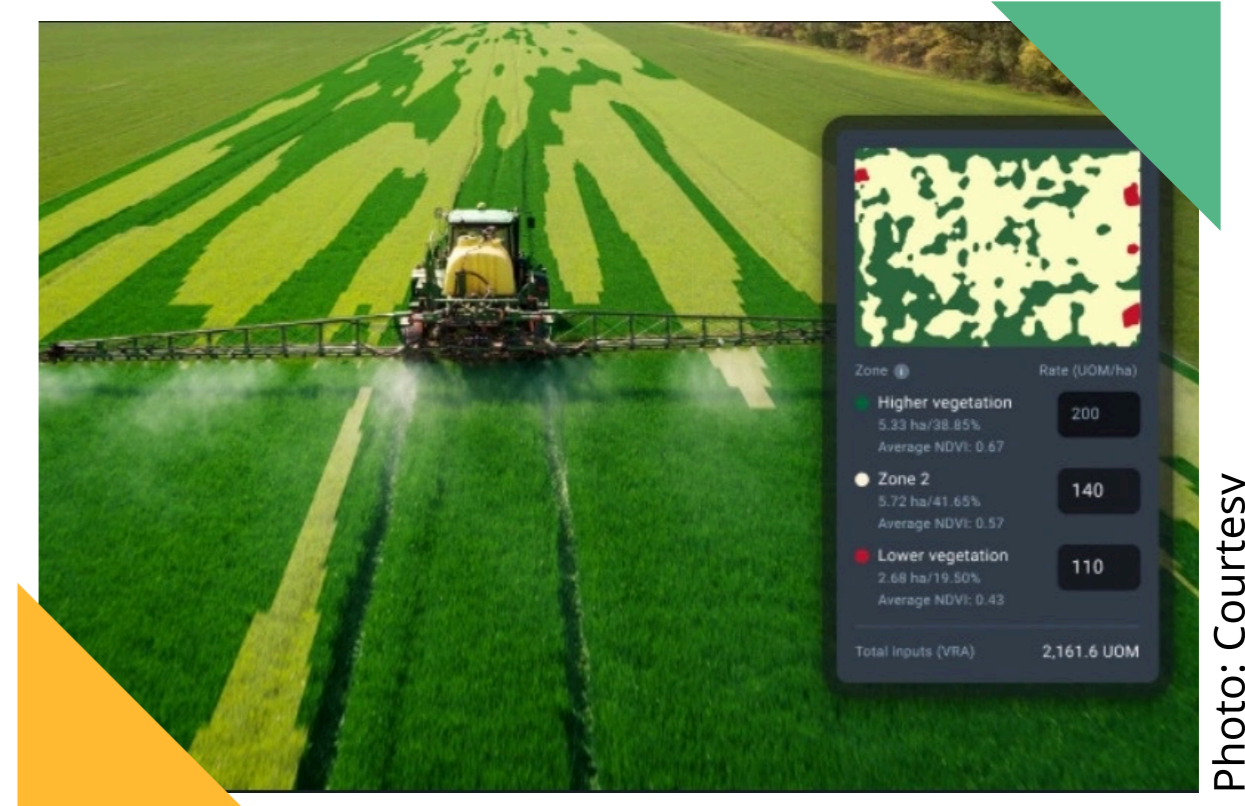


Photo: Courtesy

Precision fertilizer application is a key element of precision agriculture, which aims to optimize resource use and increase agricultural efficiency. This technology involves the use of specialized systems to determine the optimal amount and placement of fertilizers.

Operating Principles

- Creation of detailed soil maps to identify zones with different fertilizer needs.
- Variable rate application of fertilizers only where needed, reducing costs and negative environmental impact.
- Use of automated dosing systems while machinery is moving⁸⁷.
- Variable Rate Application (VRA) Systems: Utilize soil condition data to determine the optimal fertilizer rate for each area of the field⁸⁸.
- Fertigation: Application of liquid fertilizers during irrigation, allowing precise control over the amount of nutrients and water⁸⁹.

Adaptation/Mitigation Benefits

Creation of optimal growing conditions (a); fertilizer savings (m).

Environmental and/or Socio-Economic Benefits

Jobs (salaries, taxes); development of related industries (IT, IoT).

Financial Characteristics

The cost of implementing precision fertilizer application systems can include expenses for equipment and software for analyzing soil conditions and managing fertilizer application⁹⁰.

Variable rate fertilizer application equipment - from €288,750

VApplyHD module from Precision Planting for precise liquid fertilizer dosing: from €41,829.90

⁸⁶ Targeted Fertiliser Application: Use and Benefits [in Ukrainian]. K. Sergeeva. EOS Data Analytics. <https://eos.com/uk/blog/dyferentsiiovane-vnesennia-dobryv/>

⁸⁷ Fertiliser Application: Techniques, Equipment and Tips for Improving Efficiency [in Ukrainian]. T. Arestov. Egritech. <https://egritech.org/uk/vnesennya-dobryv-tehnologiya-tehnika-ta-porady-dlya-pidvyshhennya-efektyvnosti/>

⁸⁸ Spreaders and the precise application of mineral fertilisers [in Ukrainian]. V. Cherkas. Agronomy Today. <https://agronomy.com.ua/statti/1165-rozkydachi-i-tochne-vnesennia-mineralnykh-dobryv.html>

⁸⁹ Fertigation: Precise Application of Fertilisers in Fields [in Ukrainian]. V. Cherlinka. EOS Data Analytics. <https://eos.com/uk/blog/fertyhatsiia/>

⁹⁰ Features of precision fertiliser application [in Ukrainian]. iFarming. <https://ifarming.ua/resursi/osoblyvosti-tochnogo-vnesennya-mindobryv>

PROTECTIVE SHELTERBELTS

Application Area

Agricultural crop cultivation
(strawberries, raspberries, apples, walnuts)

Implementation Time

Medium

Availability in the Country

Available



Photo: Zhyttia Lisosmuhy

Protective strips provide soil erosion control, moisture retention, and improvement of soil physical properties, which positively affect the yield of agricultural crops.

Types of protective strips:

1. *Longitudinal and transverse strips*: located along the field borders to protect against wind and water erosion.
2. *Runoff control strips*: located on slopes to regulate water runoff.
3. *Riparian and gully strips*: located along ravines and gullies to protect the soil from washing away.

Adaptation/Mitigation Benefits

Snow retention and increased soil moisture (a); improvement of soil physical properties and increased fertility (a).

Environmental and/or Socio-Economic Benefits

Prevention of soil erosion by wind and water.

Financial Characteristics

The cost of establishing protective strips depends on the type of plantings and the scale of the project. On average, creating 1 hectare of protective strip can cost from 50,000 to 100,000 UAH.

The economic effect lies in reducing expenses for erosion control, increasing crop yields, and improving conditions for plant growth.



RAINWATER HARVESTING

Application Area

Processing of agricultural crops

Implementation Time

Short

Availability in the Country

Available⁹¹



Photo: Schulzie/Getty Images

The technology allows to collect and use rainwater for irrigating agricultural crops, reducing dependence on unstable precipitation.

Main methods of application:

1. Collection from greenhouse or agricultural building roofs: The water is directed into reservoirs for further use in drip irrigation systems^{92 93}.
2. Creation of micro-reservoirs: For crops grown in open soil (such as apple trees and walnuts), water is stored in small ponds or underground reservoirs^{94 95}.
3. Infiltration systems: The use of special boxes or wells to accumulate water in the soil, which increases the moisture content in the root zone⁹⁶.

Adaptation/Mitigation Benefits

A 20–30% reduction in crop losses during droughts⁹⁷ (a); Improved fruit quality thanks to a stable water supply⁹⁸ (a); A 30–50% reduction in water supply costs compared with the use of centralised sources (a)

Environmental and/or Socio-Economic Benefits

The possibility of conducting economic activities in the context of climate change (jobs, wages, taxes). For berry crops (strawberries, raspberries), yield increase by 15–25%, for walnut — by 10-20%⁹⁹.

Continued on the next page →

⁹¹ A unique experience: hydroponic strawberries [in Ukrainian]. Case study: “Hutsol” Sole Trader. Bohdan Malynovskyi. Propozytysiya. <https://propozitsiya.com/articles/dosvid-hospodarstv/unikalnyy-dosvid-sunytsya-na-hidroponitsi-keys-fop-hutsol>

⁹² Vincent Linderhof, Walter Rossi Cervi, Cora van Oosten, Confidence Duku, Mercy Derkyi, Mary Antwi, Valerie Fumey Nassah, Vassileva Ralitsa, Seth Kankam Nuamah, Albert Damoah, Ama Acheampomaa Asiedu, Stephan Aning Kwadwo, 2022. Rainwater harvesting for irrigation for climate-resilient and circular food systems; The case of Ghana’s Bono East Region. Wageningen Centre for Development Innovation, Wageningen University & Research. Report WCDI-22-204. Wageningen. <https://edepot.wur.nl/567865>

⁹³ Ertop, H., Kocięcka, J., Atilgan, A., Liberacki, D., Niemiec, M., & Rolbiecki, R. (2023). The Importance of Rainwater Harvesting and Its Usage Possibilities: Antalya Example (Turkey). *Water*, 15(12), 2194. <https://doi.org/10.3390/w15122194>

⁹⁴ Rainwater Harvesting Handbook. African Development Bank. https://bdd.pseau.org/outils/ouvrages/bafd_rainwater_harvesting_handbook.pdf

⁹⁵ Compendium on Rainwater Harvesting for Agriculture in the Caribbean Sub-region. Food and Agriculture Organization of the United Nations (FAO) 2014. <https://openknowledge.fao.org/server/api/core/bitstreams/9e1e6970-26d5-4d07-94ce-7202552e4988/content>

⁹⁶ Maciej Sawicki, Małgorzata Iwanek. The financial aspect of local rainwater management on a wind farm. GAZ, WODA I TECHNIKA SANITARNA, 2023. DOI: 10.15199/17.2023.3.5. <https://gazwoda.pl/wp-content/uploads/Openaccess/2023/101519917202335.pdf>

⁹⁷ *Journal of Water, Sanitation and Hygiene for Development* (2024) 14 (12): 1244–1259. <https://doi.org/10.2166/washdev.2024.120>

⁹⁸ Ertop, H., Kocięcka, J., Atilgan, A., Liberacki, D., Niemiec, M., & Rolbiecki, R. (2023). The Importance of Rainwater Harvesting and Its Usage Possibilities: Antalya Example (Turkey). *Water*, 15(12), 2194. <https://doi.org/10.3390/w15122194>

⁹⁹ Compendium on Rainwater Harvesting for Agriculture in the Caribbean Sub-region. Food and Agriculture Organization of the United Nations (FAO) 2014. <https://openknowledge.fao.org/server/api/core/bitstreams/9e1e6970-26d5-4d07-94ce-7202552e4988/content>

RAINWATER HARVESTING

Financial Characteristics

Capital expenditures:

- Roof water collection system: The cost of installing reservoirs and filtration systems ranges from 3 to 25 €/m³, depending on materials used^{100 101}.
- Infiltration boxes or wells: One-time equipment costs range from 500 to 2000 € for a 0.5 ha area¹⁰².

Operating expenses:

- System maintenance: 50–200 €/year, depending on complexity^{103 104}. Using rainwater helps reduce irrigation costs and increases the farm's resilience to climate change. In the long run, the technology ensures an investment return rate of 12–18% annually¹⁰⁵.



Photo: Shree Krishna Dhital

¹⁰⁰ Musz-Pomorska, A., Widomski, M. K., & Gołębiowska, J. (2024). Financial Aspects of Sustainable Rainwater Management in Small-Scale Urban Housing Communities. *Sustainability*, 16(2), 780. <https://doi.org/10.3390/su16020780>

¹⁰¹ Maciej Sawicki, Małgorzata Iwanek. The financial aspect of local rainwater management on a wind farm. *GAZ, WODA I TECHNIKA SANITARNA*, 2023. DOI: 10.15199/17.2023.3.5. <https://gazwoda.pl/wp-content/uploads/Openaccess/2023/101519917202335.pdf>

¹⁰² Maciej Sawicki, Małgorzata Iwanek. The financial aspect of local rainwater management on a wind farm. *GAZ, WODA I TECHNIKA SANITARNA*, 2023. DOI: 10.15199/17.2023.3.5. <https://gazwoda.pl/wp-content/uploads/Openaccess/2023/101519917202335.pdf>

¹⁰³ Musz-Pomorska, A., Widomski, M. K., & Gołębiowska, J. (2024). Financial Aspects of Sustainable Rainwater Management in Small-Scale Urban Housing Communities. *Sustainability*, 16(2), 780. <https://doi.org/10.3390/su16020780>

¹⁰⁴ Maciej Sawicki, Małgorzata Iwanek. The financial aspect of local rainwater management on a wind farm. *GAZ, WODA I TECHNIKA SANITARNA*, 2023. DOI: 10.15199/17.2023.3.5. <https://gazwoda.pl/wp-content/uploads/Openaccess/2023/101519917202335.pdf>

¹⁰⁵ Musz-Pomorska, A., Widomski, M. K., & Gołębiowska, J. (2024). Financial Aspects of Sustainable Rainwater Management in Small-Scale Urban Housing Communities. *Sustainability*, 16(2), 780. <https://doi.org/10.3390/su16020780>



REDUCED PESTICIDE USE

Application Area

Agricultural crop cultivation

Implementation Time

Short

Availability in the Country

Available



Photo: DepositPhotos

Reducing pesticide use¹⁰⁶ aims to enhance environmental safety and minimize negative impacts on the environment and human health.

Alternatives to Pesticides:

- **Biological Plant Protection Products:** utilize microorganisms and other natural components to control plant diseases and pests without harming the environment.
- **Innovative Technologies:** employing innovative systems such as BioBee, Alta Innovation, DriftSense, Palm Robotics, and BotanoHealth, which help reduce pesticide use through more precise application and plant health monitoring¹⁰⁷.

Principles of Reducing Pesticide Use:

- **Integrated Pest Management (IPM):** combines various plant protection methods, including biological controls, cultural and agronomic practices, and chemical agents only when necessary.
- **Plant Health Monitoring:** utilizing technologies to monitor plant health and detect pests and diseases early.

Adaptation/Mitigation Benefits

Reduced negative impact of pesticides (a, m)

Environmental and/or Socio-Economic Benefits

Jobs (salaries, taxes); reduced risk of environmental problems; no harm to bees.

Financial Characteristics

The cost of implementing innovative technologies and biological control agents depends on the type of production and the scale of the farm. These costs can be offset by reducing expenses on traditional pesticides and increasing product quality. Specific cost data could not be found.

¹⁰⁶ Pesticides: great harm, little benefit [in Ukrainian]. A. Voichikhovska, N. Kuts. "Ecology. Law. Humanity". <https://epl.org.ua/environment/pestytydy-velyka-shkoda-mala-koryst/>

¹⁰⁷ Innovations that help reduce pesticide use [in Ukrainian]. Trade and Economic Mission. <https://itrade.gov.il/ukraine/2024/06/03/інновації-що-допомагають-скоротити-в/>

REUSABLE PACKAGING

Application Area

Processing of agricultural crops

Implementation Time

Short

Availability in the Country

Available



Photo: iStock

Reusable Packaging — a system where containers are used multiple times instead of single-use ones. It is made from durable materials such as glass (jars, bottles); metal (barrels, containers); plastic (boxes, pallets); textile (bags, sacks); wood (crates, pallets).

The production cycle includes:

- collection of used containers through specialized points or logistics networks;
- cleaning and disinfection using ultrasonic systems, steam treatment, or chemical agents;
- inspection for damage to determine suitability for reuse;
- repair or disposal of unsuitable packaging.

Modern technologies:

- RFID tags for tracking the packaging lifecycle¹⁰⁸.
- Automated sorting systems for rapid processing¹⁰⁹.

Adaptation/Mitigation Benefits

The production of eco-friendly packaging often requires less energy, which has a positive impact on the environment¹¹⁰ (m) (Reduction of CO₂ emissions due to a decrease in the production of new containers).

Environmental and/or Socio-Economic Benefits

A reduction in waste volumes by 20-30% compared to single-use packaging¹¹¹; resource savings (1 glass bottle can withstand up to 50 cycles of use¹¹¹). Disadvantages: High initial costs for equipment and logistics. The need to motivate consumers to return containers (for example, deposit systems).

Financial Characteristics

Capital Costs:

- purchase of containers: 1,000–10,000 EUR per batch;
- cleaning system: 5,000–20,000 EUR;
- RFID tags: 0.5–2 EUR per unit.

Operational Costs:

- Equipment maintenance: 200–1,000 EUR per month
- Container collection logistics: 500–2,000 EUR per month.¹¹²

Return on Investment: 2–5 years for medium-sized enterprises^{112 113}.

¹⁰⁸ RFID — automatic identification technology [in Ukrainian]. Vostok. https://www.vostok.dp.ua/ukr/infa1/rfid/rfid_tekhnologiya/

¹⁰⁹ What is reusable packaging and why should you switch to it? [in Ukrainian]. TERA PLAST. <https://teraplast.com.ua/>

¹¹⁰ Is eco-friendly gift wrapping cost-effective? [in Ukrainian]. Rynekpapierniczy. <https://gofromagazine.com/yekologichna-upakovka-podarunkiv>

¹¹¹ Multi-wrap packaging: what is it and what is it used for? [in Ukrainian]. LinkPack. <https://linkpack.com.ua/bagatooborotna-upakovka-scho-ce-i-chogo-stosutsja/>

¹¹² Calculating the economic advantages of returnable plastic containers. BITO Solutions. <https://www.bitosolutions.com/en-ie/calculating-the-economic-advantages-of-returnable-plastic-containers/>

¹¹³ New study proves reusable packaging is economically viable at scale. Zero Waste Europe. <https://zerowasteurope.eu/new-study-proves-reusable-packaging-is-economically-viable-at-scale/>

ROW PROTECTION SYSTEMS

Photo: Wayfair



Application Area

Agricultural crop cultivation (strawberry, raspberry; apple, walnut – only for seedling protection)

Implementation Time

Medium

Availability in the Country

Available¹¹⁴

Protective systems for each row of plants involve using a combination of film on top and netting underneath, as well as arched structures. The technology provides individual protection for each row of plants from adverse weather conditions and pests. The film on top protects from rain and hail, while the netting underneath provides protection from insects and small animals. This design allows for регулирование (regulation) of the microclimate and ensures optimal conditions for plant growth.

Arched structures are used to support the film and netting over the rows of plants. They can be made from various materials, such as metal or plastic pipes.

Adaptation/Mitigation Benefits

Provides protection from hail and insects (a); creates an optimal microclimate for growth (a)

Environmental and/or Socio-Economic Benefits

Jobs (taxes, salaries).

Financial Characteristics

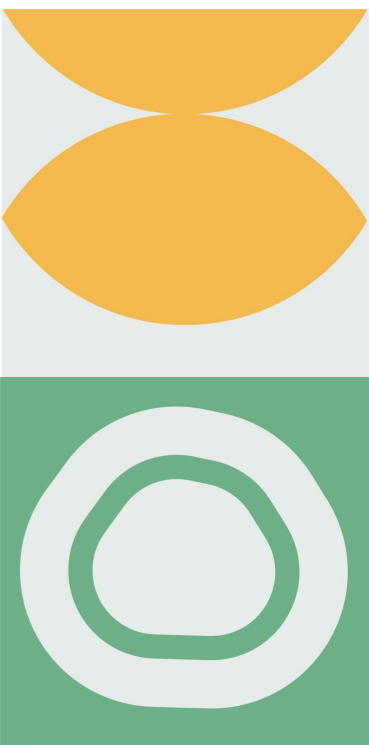
The cost of protective systems can be relatively high due to the complexity of the design and the need for manual labor during installation. The cost of arched structures and materials for film and netting can vary depending on the size and quality of the materials.

Analysis of prices for individual components of protective systems:

- Anti-hail nets: from 4855 UA
- Nets from birds: from 17 UAH/linear meter to 6350 UAH for large rolls
- Protective films: from 375 UAH per roll
- Arched structures: from 825 UAH (greenhouse tunnel for berry crops)



SOIL RETENTION TECHNIQUES IN ORCHARD ROWS



Application Area

Agricultural crop cultivation

Implementation Time

Short

Availability in the Country

Available

Soil management technologies in orchard rows include various soil care systems aimed at optimizing growing conditions for plants and increasing soil fertility.

- 1. Grass-humus system.** Used in irrigated orchards and areas with sufficient rainfall. The inter-rows of plantings are sown with perennial grasses after the tree crowns have formed. Grasses are periodically mowed and spread over the soil surface as mulch¹¹⁴.
- 2. Clean cultivation system.** The main operations are harrowing, disking, and cultivation to conserve moisture and improve soil aeration. Used to loosen the soil throughout the growing season, which can negatively affect soil structure and reduce its fertility¹¹⁵.
- 3. Green manure crops.** Sown annually or every other year to improve soil structure and conserve moisture. It is most rational to sow green manure in the second half of summer or autumn in well-prepared, moist soil.

Adaptation/Mitigation Benefits

For *strawberries and raspberries*, mulching and green manure crops can be used to conserve moisture and improve soil structure.

The *grass-humus system* and clean cultivation system can be applied for soil management in apple orchards, depending on soil and climate conditions.

For *young walnut trees*, mulching and green manure crops can be used to protect the soil and conserve moisture.

Environmental and/or Socio-Economic Benefits

Reduction in erosion control costs and increased soil fertility, leading to higher yields and product quality.

Financial Characteristics

The cost of implementing soil management systems can be up to 50,000 UAH¹¹⁶, depending on the level of automation and the type of equipment.

¹¹⁴ Soil management techniques in orchards [in Ukrainian]. I. Tymoshok. <https://agro-business.com.ua/agro/mekhanizatsiia-apk/item/1252-tekhnohii-dohliadu-za-gruntom-u-sadakh.html>

¹¹⁵ Features of the steam-based soil retention system in orchard aisles [in Ukrainian]. O. Bublik. <https://agrotimes.ua/ovochi-sad/osoblivosti-parovoyi-sistemi-utrimannya-gruntu-v-mizhryaddyah-sadu/>

¹¹⁶ Prices for landscape design services [in Ukrainian]. GreenArea. <https://greenarea.com.ua/cini/>

VARIETIES ADAPTED TO THE REGION

Application Area

Agricultural crop cultivation (strawberry, raspberry, apple, walnut)

Implementation Time

Short

Availability in the Country

Available



Photo: Silsky visnyk

Allow for predictable crop yields.

1. Strawberry (Суниця садова)

- **Quicky:** A very early variety well-suited to Ukrainian conditions due to its disease resistance and high yield.
- **Clery:** An early-ripening Italian variety that grows well in the heavy soils of Ukraine.

2. Apples (Яблука)

- **Antonovka:** A classic Ukrainian apple variety, well-adapted to the local climate.
- **Renet Simirenko:** A popular apple variety in Ukraine, known for its flavor and disease resistance.

3. Raspberry (Малина)

- **Malanka:** A Ukrainian raspberry variety with high yield and disease resistance.
- **Mriya:** Also a popular raspberry variety in Ukraine, known for its hardiness and productivity.

4. Walnut:

- **Ukrainian 17:** One of the most popular walnut varieties in Ukraine, known for its high yield and disease resistance.

Adaptation/Mitigation Benefits

Allows for predictable yields under climate change conditions (a).

Environmental and/or Socio-Economic Benefits

Possibility of growing products, including as a type of economic activity (jobs, taxes).

Financial Characteristics

Capital Expenditures: Costs for purchasing seeds or planting material of new varieties, soil preparation, and infrastructure.

Operating Expenses: Costs for plant care, the use of fertilizers, and pest control.

1. Strawberry

- **Clery:** from 140 UAH/10 pcs¹¹⁷

2. Apples:

- **Renet Simirenko:** Two-year-old seedlings are available at a price of 170 UAH/piece¹¹⁸
- **Antonovka:** from 179 UAH/piece¹¹⁹

3. Raspberry:

- **Mriya:** from 250 UAH/10 pcs¹²⁰

4. Walnut: from 270 UAH/piece¹²¹

¹¹⁷ Clary Early strawberry plant [in Ukrainian]. Fruktovyy sad. <https://www.fruitsad.shop/yagidni-sadzhanci/polunitsya/sadzhane-polunyci-kleri-rannij>

¹¹⁸ Kompaniya «Hektar». <https://hectare.ua>

¹¹⁹ Antonivka Apple Tree (late variety) [in Ukrainian]. SadOK. <https://sadokshop.com.ua/ua/plodovye-derevya/yablonia/antonovka>

¹²⁰ Maria Raspberry – summer, early [in Ukrainian]. Lityn Sad. [https://litynsad.com.ua/malyna-mariya-litnya-rannya?](https://litynsad.com.ua/malyna-mariya-litnya-rannya?srsltid=AfmBOopckmaH3I69t8KnrdZbGtEvNCs6W2J_Rxa1WiQNiMPttoPzrjm)

[srsltid=AfmBOopckmaH3I69t8KnrdZbGtEvNCs6W2J_Rxa1WiQNiMPttoPzrjm](https://litynsad.com.ua/malyna-mariya-litnya-rannya?srsltid=AfmBOopckmaH3I69t8KnrdZbGtEvNCs6W2J_Rxa1WiQNiMPttoPzrjm)

¹²¹ Grafted walnut seedlings [in Ukrainian]. Sady Bukovyny. <https://sadubukovunu.com.ua/sazhency-greckogo-oreha-funduka-mindalya/sazhency-greckogo-oreha/privitye-sazhency-greckogo-oreha/?sort=p.price&order=ASC&limit=120>

VERTICAL FARMS

Application Area

Agricultural crop cultivation (strawberry)

Implementation Time

Medium

Availability in the Country

Available¹²²

Photo: AeroFarms



Highly automated complexes where plants are grown using hydroponics or aeroponics in enclosed spaces. Characterized by multi-level placement of plantings, which allows for increased yields per unit area. They allow for controlled environmental conditions, including temperature, lighting, and humidity, which ensures yield stability regardless of natural conditions. Vertical farms use only 5% of the water compared to traditional farming methods¹²³. Absence of pesticide and herbicide use due to a closed ventilation and air purification cycle.

Adaptation/Mitigation Benefits

Provides significant water savings compared to traditional agriculture (a); resistance to adverse weather conditions (a); nutrient savings (a, m); reduced need for herbicides and pesticides (no weeds) (m)

Environmental and/or Socio-Economic Benefits

Produce is clean from nitrates and pesticides; space saving, jobs (salaries, taxes).

Financial Characteristics

Minimum capital investment - \$50,000 USD, operational - \$57,000 USD/year¹²⁴. Payback - from three years.

¹²² Vertical farms could save us from famine. What is grown there and how — insights from farmers in the US and Ukraine [in Ukrainian].. Anastasia Shkalova. Vector. <https://vctr.media/ua/vertikalni-fermi-mozhut-vryatuvati-nas-vid-golodu-shho-ta-yak-tam-viroshhuyut-dosvid-fermeriv-ssha-j-ukrayini-117103/>

¹²³ Vertical farms could save us from famine. What is grown there and how — insights from farmers in the US and Ukraine [in Ukrainian].. Anastasia Shkalova. Vector. <https://vctr.media/ua/vertikalni-fermi-mozhut-vryatuvati-nas-vid-golodu-shho-ta-yak-tam-viroshhuyut-dosvid-fermeriv-ssha-j-ukrayini-117103/>

¹²⁴ Vertical farms could save us from famine. What is grown there and how — insights from farmers in the US and Ukraine [in Ukrainian].. Anastasia Shkalova. Vector. <https://vctr.media/ua/vertikalni-fermi-mozhut-vryatuvati-nas-vid-golodu-shho-ta-yak-tam-viroshhuyut-dosvid-fermeriv-ssha-j-ukrayini-117103/>

WATER RECYCLING

Photo: waterTech



Application Area

Cultivation and processing of agricultural crops

Implementation Time

Short/medium

Availability in the Country

Available



Cyclical water use in agricultural product processing is an important measure to reduce water consumption and increase the environmental sustainability of production¹²⁵. Unlike cultivation, where water is used for irrigation, in processing, water is used for washing, sorting, cooling, and other technological processes.

Methods of Cyclical Water Use

1. *Cascade water use*: Water used for one stage of processing is reused for another where water quality requirements are lower. For example, water from the initial washing of apples can be used for pre-soaking or transporting the fruit.
2. *Water purification*: Application of water treatment systems to remove contaminants and microorganisms¹²⁶. This can include filtration, ultrafiltration, reverse osmosis, ultraviolet disinfection, or ozonation.
3. *Reuse of water after washing*: Collection of water used for washing fruits and berries, its purification, and reuse for the same or other processes.
4. *Closed-loop water supply systems*: Creation of fully closed water supply cycles where water constantly circulates between different stages of production after appropriate treatment¹²⁷.

Adaptation/Mitigation Benefits

Reduction in the need for new water by 50-90%¹²⁸ (a); reduction in the volume of wastewater requiring disposal (m); reduction in the costs of heating and cooling water due to temperature stabilization in closed-loop systems (m).

Environmental and/or Socio-Economic Benefits

Possibility of conducting economic activity under climate change conditions (jobs, salaries, taxes).

Continued on the next page →

¹²⁵ The priority is to conserve water resources and reuse treated water [in Ukrainian]. 'Sativnytstvo' magazine. 'Technologies and Innovations' media group. <https://techhorticulture.com/u-prioryteti-ekonomiya-vodnyh-resursiv-i-povtorne-vykorystannya-ochyshhenoyi-vody/>

¹²⁶ The priority is to conserve water resources and reuse treated water [in Ukrainian]. 'Sativnytstvo' magazine. 'Technologies and Innovations' media group. <https://techhorticulture.com/u-prioryteti-ekonomiya-vodnyh-resursiv-i-povtorne-vykorystannya-ochyshhenoyi-vody/>

¹²⁷ The priority is to conserve water resources and reuse treated water [in Ukrainian]. 'Sativnytstvo' magazine. 'Technologies and Innovations' media group. <https://techhorticulture.com/u-prioryteti-ekonomiya-vodnyh-resursiv-i-povtorne-vykorystannya-ochyshhenoyi-vody/>

¹²⁸ The priority is to conserve water resources and reuse treated water [in Ukrainian]. 'Sativnytstvo' magazine. 'Technologies and Innovations' media group. <https://techhorticulture.com/u-prioryteti-ekonomiya-vodnyh-resursiv-i-povtorne-vykorystannya-ochyshhenoyi-vody/>



WATER RECYCLING

Financial Characteristics

Capital Expenditures:

- water collection and storage systems: Cost of installing tanks for water collection and storage — €1,000 - €5,000 depending on volume;
- water treatment equipment: Cost of filters, reverse osmosis units, ultraviolet sterilizers — €5,000 - €30,000 depending on technology and capacity¹²⁹;
- water quality monitoring and control systems: Cost of sensors, automatic control systems — €1,000 - €5,000.

Operating Expenses:

- energy for pumps and purification: Electricity costs for pumping water and operating treatment systems — €500 - €3,000/year;
- maintenance: Cost of servicing filters, pumps, and other equipment — €200 - €1,500/year;
- water analysis: Regular water quality analysis to monitor treatment effectiveness — €100 - €500/year;
- costs for chemical reagents: (if necessary) Cost of reagents for chemical water treatment (e.g., for pH correction) — €100 - €500/year.

With efficient water resource management and the implementation of modern treatment technologies, the **payback period for investments in cyclical water use systems is 2-6 years.**



¹²⁹ The priority is to conserve water resources and reuse treated water [in Ukrainian]. 'Sadivnytstvo' magazine. 'Technologies and Innovations' media group. <https://techhorticulture.com/u-prioryteti-ekonomiya-vodnyh-resursiv-i-povtorne-vykorystannya-ochyshhenoyi-vody/>

