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GOOD PRACTICE REPORT

International Good Practices in Precision Agriculture and Smart Farming

Documented cases from Germany, France, the Netherlands, Greece and EU-wide initiatives, and what they mean for Türkiye

Precision Farming for a Greener Tomorrow: Advocating for Sustainable Agriculture
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VERDE
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EXECUTIVE SUMMARY

European farms are already using these tools. The lessons are practical, and most of them travel.

This report presents **28 documented good practices** in precision agriculture and smart farming from Germany, France, the Netherlands and Greece, including 2 EU-wide initiatives, with 13 further short examples, grouped in five themes: precision agriculture; smart farming technologies; farm data management; agricultural robotics; and augmented reality, virtual reality and simulation in drone training. Each case is described with its implementers, funding, scale and published results, and assessed for transfer to Türkiye.

EUROPEAN UNION

18%

of EU farms used at least one precision farming technology or practice in 2023. These farms managed about 44% of the EU's utilised agricultural area.[1]

TÜRKIYE

< 3 in 100

farmers used smart farming technologies in 2020, according to the Ministry of Agriculture and Forestry's farmer survey.[2] The two surveys use different definitions; the gap is indicative, not exact.

Five messages

1. **Start from a decision the farmer already makes.** The strongest cases (nitrogen advice from satellite images, irrigation scheduling from soil sensors, variable-rate task maps) improve one existing decision rather than introducing a whole system.
2. **Public bodies make the difference in data.** State-run data portals, national field labs and sector data codes give farmers neutral infrastructure and clear rules on who may use their data.
3. **Robots reach small farms through services.** Contractor models, shared machines and autonomy kits fitted to standard tractors lower the entry cost; independent public evaluations show where robots work and where hand labour remains.
4. **Training is part of the technology.** Simulators, VR stations and blended online courses are already used in agricultural training in France, Germany and Greece, and EU rules require drone pilots to complete training and pass exams before most operations.
5. **Farmers learn from farmers.** In a JRC survey of 971 farmers in five European countries, farmers who had adopted machine guidance or variable-rate nitrogen were most influenced by what they learned from other farmers.[3]

[1] Eurostat (2026). 43% of EU farms with internet access. News item, 24 July 2026, data from the 2023 Integrated Farm Statistics. https://ec.europa.eu/eurostat/en/web/products-eurostat-news/w/ddn-20260724-1

[2] Ministry of Agriculture and Forestry of Türkiye, 2020 farmer survey, cited in Höllinger, F. and Sener, B.S. (2025). Digital technologies for agriculture in Türkiye: A review. FAO and EBRD, Country Investment Highlights No. 25, p. 49. https://openknowledge.fao.org/items/3fb108cf-ba1a-4044-83da-60c6ada235ce

[3] Soto, I. et al. (2019). The contribution of Precision Agriculture Technologies to farm productivity and the mitigation of greenhouse gas emissions in the EU. JRC, EUR 29320 EN, p. 22. doi:10.2760/016263

What this means for Türkiye

Türkiye's conditions make several of these practices especially relevant. Irrigation takes 77% of the water used in the country,[1] and in the irrigation schemes of the State Hydraulic Works (DSİ) irrigation efficiency stayed at 52% in 2025.[2] The farming population is ageing: in 2024 only 5% of members of the chambers of agriculture were aged 18 to 32.[3] At the same time, the policy frame has moved: under Communiqué No. 2026/10, accepted applicants receive a 70% grant for sensor-based smart irrigation and automation.[4]

RECOMMENDATIONS

- **Pilot "decision services", not gadgets:** soil-moisture-based irrigation advice and satellite-based crop maps on the project's pilot fields in Şanlıurfa, Adana, İzmir, Ankara and Sakarya, delivered through extension agents and cooperatives.
- **Build neutral data infrastructure:** farmer consent rules and a sector data code before any platform; learn from GeoBox (Germany), JoinData (Netherlands) and the Data-Agri label (France).
- **Offer machines as a service:** cooperative or contractor models for drones, robots and autonomy kits, with independent field evaluation.
- **Make simulation part of training:** combine online theory, simulator practice and supervised field flights for young farmers and advisers, in line with civil aviation rules.
- **Use peer learning:** farmer-to-farmer days on pilot fields and study visits, documented so that results can be compared.

How the cases were selected and checked

Cases were screened for innovation, replicability, documented impact, scalability and relevance to the project. For this final version, every case and figure was checked against primary sources. Where the evidence is only qualitative, the case says so; where a figure comes only from a company, it is labelled.

[1] Ministry of Agriculture and Forestry of Türkiye (2023). Water Efficiency Strategy and Action Plan 2023–2033, pp. 20 and 43 (DSİ, 2021 data).

[2] State Hydraulic Works (DSİ) (2026). 2025 Annual Report, p. 109.

[3] Union of Turkish Chambers of Agriculture (TZOB) (2025). Press release, 15 October 2025 (World Rural Women's Day). https://www.tzob.org.tr/15-ekim-dunya-kadin-ciftciler-gunu-7/

[4] Ministry of Agriculture and Forestry of Türkiye (2026). Communiqué No. 2026/10, Official Gazette, 3 April 2026, Articles 4 and 11. https://www.resmigazete.gov.tr/eskiler/2026/04/20260403-10.htm

Good practices at a glance

28 full cases in five themes. The dots show the authors' assessment of transferability to Türkiye (one dot low, three dots high).



CASE	COUNTRY	THEME	TRANSFER
Farmstar	France	3.1.1 Precision Agriculture	●●○
Drone spraying in steep vineyards	Germany	3.1.1 Precision Agriculture	●●○
LIFE GAIA Sense / gaiasense	Greece	3.1.2 Precision Agriculture	●●●
NPPL precision farming field lab	Netherlands	3.1.2 Precision Agriculture	●●●
Irrinov	France	3.1.3 Precision Agriculture	●●●
LUCAS Soil survey	EU-wide	3.1.3 Precision Agriculture	●●○
Het Nieuwe Telen	Netherlands	3.2.1 Smart Farming Technologies	●●○
Crop-Steered Dynamic Agrivoltaics	France	3.2.1 Smart Farming Technologies	●●○
Autonomous Greenhouse Challenge	Netherlands	3.2.2 Smart Farming Technologies	●●○
Water-Efficient Emission-Free Greenhouse	Netherlands	3.2.2 Smart Farming Technologies	●●●
agrirouter	Germany	3.3.1 Farm Data Management	●●○
GeoBox infrastructure	Germany	3.3.1 Farm Data Management	●●●
JoinData	Netherlands	3.3.2 Farm Data Management	●●●
Akkerweb and farmmaps	Netherlands	3.3.2 Farm Data Management	●●○
Data-Agri charter and label	France	3.3.3 Farm Data Management	●●●
EU Agricultural Data Code	EU-wide	3.3.3 Farm Data Management	●●●
Bakus vineyard robot, contractor model	France	3.4.1 Agricultural Robotics	●●○
LWG Bavaria hoeing-robot trials	Germany	3.4.1 Agricultural Robotics	●●●
AgXeed AgBot in Robot zoekt Boer	Netherlands	3.4.2 Agricultural Robotics	●●○
Ex-demo autonomous tractor in an orchard	Netherlands	3.4.2 Agricultural Robotics	●●○
BACCHUS grape-harvesting robots	Greece	3.4.3 Agricultural Robotics	●○○
ROBS4CROPS table-grape spraying pilot	Greece	3.4.3 Agricultural Robotics	●●○
Vinum: E-CAB and Ampélos	France	3.5.1 AR/VR and Simulation in Drone Training	●●○
SilA: VR stations in farm VET	Germany	3.5.1 AR/VR and Simulation in Drone Training	●●●
Augmented Horticulture	Netherlands	3.5.2 AR/VR and Simulation in Drone Training	●●○
GoDrone airspace app	Netherlands	3.5.2 AR/VR and Simulation in Drone Training	●●○
AgroPro drone MOOC	Greece	3.5.3 AR/VR and Simulation in Drone Training	●●●
Drones4GREEN simulation training	Greece	3.5.3 AR/VR and Simulation in Drone Training	●●●

1 Introduction

1.1 Background and context

Agriculture in Europe and globally faces a double pressure: to produce enough food and to reduce its environmental impact. Climate change, water scarcity, soil degradation and labour shortages add to it. Precision agriculture and smart farming respond by measuring what happens in the field and using that information to apply water, fertiliser and plant protection where and when they are needed.

Adoption in Europe is real but uneven. In 2023 about 18% of EU farms applied some kind of precision farming technology or practice, and these farms managed about 44% of the EU's utilised agricultural area; variable rate techniques were used by 5.3% of holdings.[1] Eurostat notes that limited access to infrastructure and advice may explain very low uptake in some regions.[1] Only 10.7% of EU farm managers are younger than 40.[2]

Technology alone does not explain success. What makes a practice work is the combination of a useful service, trusted data rules, advice and training, and financing that fits the size of the farm.

1.2 Purpose of the report

This report offers a structured, practice-oriented reference for the project consortium, policy makers, training institutions and agri-technology stakeholders. It:

- identifies and documents good practices from Germany, France, the Netherlands, Greece and EU-wide initiatives;
- shows how they were implemented and scaled, and what they achieved, as far as results are published;
- assesses their transferability to Türkiye and proposes pilot models;
- supports partners in building a shared understanding of viable technologies and governance models.

[1] Eurostat (2026). 43% of EU farms with internet access (24 July 2026) and Agriculture statistics at regional level, Eurostat regional yearbook 2026. https://ec.europa.eu/eurostat/en/web/products-eurostat-news/w/ddn-20260724-1

[2] Eurostat (2026). Farmers and the agricultural labour force: statistics (Statistics Explained, data 2023). https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Farmers_and_the_agricultural_labour_force_-_statistics

1.3 Development process

The process involved:

- desk research and literature review of EU-funded initiatives (Horizon 2020 and Horizon Europe, Erasmus+, EIP-AGRI Operational Groups, LIFE, CAP and national programmes);
- review of peer-reviewed publications, ministry and agency portals, and the pages of the implementing organisations;
- consultation with partners and experts in Türkiye and the EU on relevance and usability;
- a final verification round in October 2026, in which every case, actor and figure was traced to a primary source.

FROM THE PROJECT: STUDY VISIT TO ATHENS, JUNE 2026

From 9 to 12 June 2026 a project delegation of farmers, agricultural engineers and technical staff, coordinated by YKD and TARIMKON and hosted by the Athens-based civil society organisation KEAN (Cell of Alternative Youth Activities), visited academic institutions, field sites and civil society organisations in Athens.[1,2] At the Agricultural University of Athens the group saw GPS-based monitoring, satellite remote sensing and chlorophyll measurement in research laboratories; at Agro-Farm, thermal and multispectral drones, smart irrigation and software-supported fertilisation; and with KEAN it discussed young people's participation in agriculture and the circular economy.[1,2] The project plans to apply satellite-linked crop monitoring of the kind seen in Athens on a limited scale on its pilot fields.[2]

Structure of the report

Chapter 2 explains how practices were identified and checked. Chapter 3 presents the cases in five themes, each closing with a comparison and its lessons. Chapter 4 draws common lessons and recommendations, chapter 5 discusses transfer to Türkiye and pilot models, and chapter 6 concludes.

[1] Project website (2026). Yunanistan Uluslararası Teknik Ziyaretimiz Gerçekleştirildi (14 June 2026). https://www.surdurulebilirhasat.org.tr/daha-yesil-yarinlar-icin-hassas-tarim-surdurulebilir-tarim-savunuculugu-projesi-kapsaminda-yunanistan-uluslararasi-teknik-ziyaretimiz-gerceklestirildi/

[2] Project website (2026). Atina'dan Beş İle Uzanan Dersler: Hassas Tarımın Saha Karnesi. https://www.surdurulebilirhasat.org.tr/atinadan-bes-ile-uzanan-dersler-hassas-tarimin-saha-karnesi/

2
Methodology and sources

2.1 Approach to identifying good practices

The report follows a criteria-based approach. Practices had to be technically sound, documented, and transferable to small and mid-sized farms. The method combined desk research in scientific databases, innovation portals and policy repositories; case selection guided by the project's five themes; a uniform template for every case; and review by partners and experts.

Each practice is documented with the same elements: **what it is; implementers; programme and funding; period and scale; how it works; results; relevance to Türkiye; transferability.**

2.2 Sources reviewed

PROGRAMMES AND AGENCIES

- CORDIS records of Horizon 2020 and Horizon Europe projects
- EU CAP Network (EIP-AGRI) Operational Group database
- LIFE and Erasmus+ project pages
- Ministries and agencies: BMEL and BLE (DE), INRAE and the Ministry of Agriculture (FR), WUR and RVO (NL), Agricultural University of Athens and CERTH (GR)

LITERATURE AND STATISTICS

- Peer-reviewed articles and systematic reviews
- Independent public field evaluations (for example LWG Bavaria)
- Eurostat, the Joint Research Centre and FAO
- Turkish official statistics and legislation (TurkStat, Ministry of Agriculture and Forestry, DSİ, Official Gazette)

2.3 Selection criteria

CRITERION	EXPLANATION
Innovation	Introduces a technical or organisational solution to a known challenge
Replicability	Documented well enough to be transferred to other regions or production systems
Impact	Results are published: yield, cost, resource use, sustainability or inclusion
Scalability	Can move from pilot to broad use with a manageable adaptation effort
Relevance	Directly related to the themes and technologies targeted in the project

2.4 Validation and verification

To ground the findings in local realities, partners and experts reviewed the practices against Türkiye's farming systems, especially smallholder and mixed cropping, and assessed language, cost and training requirements for transfer.

VERIFICATION RULES APPLIED IN THIS FINAL VERSION

- A case is included only if it is documented on a primary or authoritative source: an official programme or project page, a public agency, the implementing organisation, or a peer-reviewed publication.
- Every actor, date, budget, scale and result figure was traced to a verbatim passage in its source. Sources were accessed on 23 October 2026.
- Figures published only by the company that sells a technology are labelled "reported by the company".
- Where no result figures are published, the case says so instead of estimating them.
- Cases and figures from the working draft that could not be confirmed in their sources were replaced by documented practices in the same subtheme.

Limits of the evidence

Many good practices are still pilots. Published results often come from the project that ran the pilot, measure different things and are not directly comparable. Transferability ratings are the authors' assessment, not a measured value. Statistics from Türkiye and the EU are cited with their year and definition; where definitions differ, the comparison is indicative.

Transferability scale

RATING	MEANING
High ● ● ●	Can be piloted in Türkiye with existing institutions and modest adaptation
Medium ● ● ○	Needs a partner, calibration to local crops, or financing support
Low ● ○ ○	Depends on infrastructure, regulation or farm structures not yet in place

3.1

Precision Agriculture

This theme covers tools that measure crops, soil and water and turn the data into field decisions: satellite and drone monitoring, data-based nutrient and irrigation advice, and soil sensing. These practices matter for Türkiye because they address water scarcity, input costs and small, fragmented parcels.



Haliliye (Şanlıurfa): maize field visit during young farmers training, July 2026. AI-assisted illustration based on a real project photograph.

FR	Farmstar	3.1.1
DE	Drone spraying in steep vineyards	3.1.1
GR	LIFE GAIA Sense / gaiasense	3.1.2
NL	NPPL precision farming field lab	3.1.2
FR	Irrinov	3.1.3
EU	LUCAS Soil survey	3.1.3

FR
FRANCE

3.1.1 · SATELLITE AND DRONE-BASED MONITORING

Farmstar

Satellite-based nitrogen advice for cereals and rapeseed, delivered to farmers through distributors and their technicians.

WHAT IT IS

Farmstar is a nitrogen advice service created in 2001 by Airbus and the French technical institutes Arvalis and Terres Inovia [1]. Satellite images give two variables, canopy nitrogen concentration and biomass [1]. Arvalis models cereal crops and Terres Inovia rapeseed, and the institutes turn these into recommendations [2]. Advice covers wheat, barley, rapeseed and its companion plant at intra-field scale, from seeding to harvest [3].

HOW IT WORKS

- Images are processed into canopy nitrogen concentration and biomass, the two variables behind the diagnosis [1].
- Arvalis and Terres Inovia crop models convert these variables into nitrogen recommendations for the customer [2].
- 35 selected distributors and more than 1,000 technicians deliver the advice to farmers each season [3].

RESULTS

680,000 ha
covered annually across more than 90,000 parcels [3]
company figure

12,500
farmers served every season through 35 distributors [3]
company figure

Figures reported by the company.

No independent figure on nitrogen savings was found. Trade press reported in 2020 that use had plateaued at 600,000 hectares [1]. The ESA-funded FARMEX project is adapting the service to other European countries, with a pilot phase in Greece [4].

WHY IT MATTERS FOR TÜRKIYE

For cereal areas in pilot provinces such as Ankara and Şanlıurfa, Farmstar shows that satellite advice reaches farmers when an agronomic institute owns the crop models and cooperatives or dealers deliver the advice. A Turkish version would depend on local nitrogen models for national varieties, not on imported imagery alone.

TRANSFERABILITY

Requires nitrogen models calibrated for Turkish varieties, soils and climate, a body that maintains them, and a cooperative or dealer channel. The FARMEX export project shows the service is being adapted outside France [4].

IMPLEMENTERS

Airbus (imagery) with the French technical institutes Arvalis (cereal models) and Terres Inovia (rapeseed models) [1,2]

PROGRAMME AND FUNDING

Private paid service; ESA funds the FARMEX project adapting it abroad [4]

PERIOD

since 2001

SCALE

680,000 ha a year, over 12,500 farmers (company figures) [3]

TECHNOLOGY

Satellite imagery, canopy nitrogen and biomass indicators, crop models

TRANSFERABILITY TO TÜRKIYE

Medium

[1] Pleinchamp (2020). Farmstar paré au décollage avec Eco et Neo. Pleinchamp (trade press), 22 September 2020. https://www.pleinchamp.com/actualite/farmstar-pare-au-decollage-avec-eco-et-neo

[2] Airbus (2020). Airbus brings satellite imaging down to earth for sustainable farming. Airbus Newsroom. https://www.airbus.com/en/newsroom/news/2020-07-airbus-brings-satellite-imaging-down-to-earth-for-sustainable-farming

[3] Airbus Defence and Space (2026). Farmstar: empowering farmers with satellite-based precision agriculture. Product page. https://space-solutions.airbus.com/industries/agriculture/precision-farming/farmstar/

[4] EARSC (2025). Towards a DST to manage nitrogen fertilization with satellite imagery: an Airbus x TerraNIS collaboration. EO Mag. https://eomag.eu/towards-a-dst-decision-support-tool-to-manage-nitrogen-fertilization-with-satellite-imagery-an-airbus-x-terranis-collaboration/

DE
GERMANY

3.1.1 · SATELLITE AND DRONE-BASED MONITORING

Drone spraying in steep vineyards

Authorised drone spraying of plant protection products on steep-slope vineyards, an alternative to crewed helicopters under strict conditions.

WHAT IT IS

German and EU law prohibit aerial spraying, but steep-slope vineyards can receive derogations when aerial application causes less environmental impact [1]. By 2021 BVL had authorised several products for drone use on steep slopes [2]. Only sprayers with JKI-tested air-induction nozzles may be used, and each application needs state approval [2]. For the 2022 season, the state supervisory authority ADD Trier received nine applications for drone spraying on steep slopes in Rhineland-Palatinate [3].

HOW IT WORKS

- Drones fly preset routes automatically, at most 2 m above the canopy and 13 km/h [2].
- BVL publishes and updates the list of authorised products with extra conditions for drone use [4].
- The state extension service DLR Mosel set up the aviation permit procedure with the transport authority [3].

RESULTS

9
applications for drone spraying filed in Rhineland-Palatinate [3]
2022 season; six approved

38 ha
planned drone-treated area on two demonstration estates [3]
Mosel, 2022

14,000 ha
steep-slope vineyards in Germany, about 14% of vine area [1]
estimate cited in JKI study

Field trials found spray drift substantially lower than with crewed helicopters; with air-induction nozzles it was below the reference values for ground sprayers [1]. The state ministry notes that area capacity is still limited [3].

WHY IT MATTERS FOR TÜRKIYE

The project's drone training and flight-simulation work can use this case to show the full chain behind a legal spraying flight: tested equipment, product lists, permits and drift data. Where Turkish vineyards and orchards lie on steep slopes, drones address the same access problem in small, hard-to-reach parcels [3].

TRANSFERABILITY

Needs national drift data, an authorisation route for drone-applied products, tested nozzles and trained pilots. EU rules allow only narrow derogations for aerial spraying, so the model fits slopes where ground machines cannot work [1].

IMPLEMENTERS

BVL (product authorisation), Julius Kühn-Institut (sprayer tests), state authorities and DLR Mosel (permits, demonstrations) [2,3]

PROGRAMME AND FUNDING

Public regulatory pathway; no dedicated funding programme identified

PERIOD

since 2021

SCALE

9 applications from 8 wine estates and one firm, 2022 [3]

TECHNOLOGY

Autonomous spraying drones (DJI Agras T30) with air-induction nozzles

TRANSFERABILITY TO TÜRKIYE

Medium

[1] Herbst, A., Glaser, M., Bartsch, K.-U. (2023). Spray drift from application of plant protection products with drones in vineyards. Journal für Kulturpflanzen 75(05-06), 151-157. https://doi.org/10.5073/JfK.2023.05-06.04

[2] Herbst, A., Pucelik-Günther, P. (2021). Anwendung von Pflanzenschutzmitteln im Steillagenweinbau mit unbemannten Luftfahrzeugen (Drohnen). Journal für Kulturpflanzen 73(7-8), 306. https://doi.org/10.5073/JfK.2021.07-08.15

[3] Ministerium für Wirtschaft, Verkehr, Landwirtschaft und Weinbau Rheinland-Pfalz (2022). Einsatz von Drohnen im Steillagenweinbau Rheinland-Pfalz. Landtag Vorlage 18/2265. https://dokumente.landtag.rlp.de/landtag/vorlagen/2265-V-18.pdf

[4] BVL (2026). Liste der Pflanzenschutzmittel, die für die Anwendung mit unbemannten Luftfahrzeugen (Drohnen) genehmigt sind. Stand 11 May 2026. https://www.bvl.bund.de/SharedDocs/Downloads/04_Pflanzenschutzmittel/psm_drohnen.html

GR
GREECE

3.1.2 · DATA- AND AI-SUPPORTED NUTRIENT AND IRRIGATION ADVICE

LIFE GAIA Sense / gaiasense

EU LIFE demonstration of smart farming advice that cut water, fertiliser and pesticide use in Mediterranean crops.

WHAT IT IS

LIFE GAIA Sense, coordinated by the Greek company NEUROPUBLIC, demonstrated an affordable smart farming system [1] built on the company's gaiasense service [2]. It ran 18 demonstrations in Greece, Spain and Portugal on nine crops, including olives, peaches, cotton, tomatoes and kiwi [1]. The project team advised participating farmers and cooperatives, leading to marked reductions in resource use [1]. The system was designed to be affordable for both cooperatives and individual farmers [1].

HOW IT WORKS

- Weather stations give field-specific forecasts and alerts; the company lists more than 400 stations [3].
- Advice targets the main inputs: water, fertilisers, pesticides and fuel [1].
- Cooperatives took part as project partners, including Greek agricultural cooperatives and a Portuguese cooperative confederation [1].

RESULTS

−33%
fertiliser use in the demonstrations [1]
18 demonstrations, 2018–2022

−18%
water use in the demonstrations [1]
18 demonstrations, 2018–2022

−24%
pesticide use; fuel use fell by 40% [1]
18 demonstrations, 2018–2022

Results are project-reported; the summary does not state baselines or methods [1]. The project found the approach attractive for small-scale farmers who do not need expensive equipment, and its communication reached more than 150,000 farmers [1].

WHY IT MATTERS FOR TÜRKIYE

The case matches Türkiye's Mediterranean crops, small parcels and cooperative structure. Irrigated areas in Adana, İzmir and Şanlıurfa could test a cooperative-run station network with advice delivered by local agronomists. The main lesson is that the savings came from advice to farmers, not from costly equipment on each farm.

TRANSFERABILITY

Needs a station network, advice models calibrated for local crops and agronomists to deliver the advice. A cooperative or regional body should own the service so that it continues after project funding ends.

IMPLEMENTERS

NEUROPUBLIC (coordinator), Aristotle University of Thessaloniki, Greek, Spanish and Portuguese cooperatives [1]

PROGRAMME AND FUNDING

EU LIFE programme (LIFE17 ENV/GR/000220); EU contribution €1,751,574 [1]

PERIOD

2018–2022

SCALE

18 demonstrations, nine crops, three countries [1]

TECHNOLOGY

Field weather stations, farm data and an online advisory service

TRANSFERABILITY TO TÜRKIYE

High

[1] European Commission, CINEA (2022). Innovative Smart Farming services supporting Circular Economy in Agriculture (LIFE GAIA Sense), LIFE17 ENV/GR/000220. LIFE Public Database. https://webgate.ec.europa.eu/life/publicWebsite/project/LIFE17-ENV-GR-000220/innovative-smart-farming-services-supporting-circular-economy-in-agriculture

[2] LIFE GAIA Sense consortium (2026). LIFE GAIA Sense: Smart Farming in 4 Dimensions. Project website. https://lifegaiasense.eu/

[3] NEUROPUBLIC (2026). gaiasense smart farming. Company website. https://www.gaiasense.gr/en/

NL
NETHERLANDS

3.1.2 · DATA- AND AI-SUPPORTED NUTRIENT AND IRRIGATION ADVICE

NPPL precision farming field lab

Publicly funded field lab that coaches Dutch farmers in variable-rate task maps and reports savings and barriers.

WHAT IT IS

The Nationale Proeftuin Precisielandbouw (NPPL) is run by Wageningen University & Research as policy-support research for the Dutch agriculture ministry [1]. From 2018 to 2021 about 20 precision agriculture applications were introduced on arable and dairy farms and about 30 farmers applied them [1]. The second phase focuses on soil, water, biodiversity and lower fertiliser and pesticide emissions [1]. In 2025 specialists coached selected growers in variable-rate application with task maps [2].

HOW IT WORKS

- Task maps based on soil maps, biomass maps or satellite images set variable rates for machines [2,3].
- Simple uses, such as spraying only over the crop rows, are tested alongside complex task maps [2].
- Coaching records practical failures, such as wrong assumptions about machine capacity, file formats and time pressure [2].

RESULTS

~30%
less crop protection product by spraying over the rows only [2]
one arable farm, 2025

~25%
average pesticide and N-fertiliser saving with potato variable-rate application [3]
WUR on-farm research, not NPPL

20–47%
less herbicide with variable-rate potato haulm killing [3]
Dutch field trials

The 2025 report concludes that variable-rate techniques are technically feasible but often too complex, time-consuming and error-prone in daily practice; the main barrier is ease of use and clear economic value, not technology [2].

WHY IT MATTERS FOR TÜRKIYE

Turkish cooperatives and young farmers considering precision equipment need this kind of evidence: what saves inputs on real farms and what goes wrong. A field lab with selected pilot farms in provinces such as Adana or Sakarya, coached by a research institute, could start with simple techniques before detailed maps.

TRANSFERABILITY

Needs public funding, a research institute able to coach farmers, and machines that accept task maps. The Dutch results suggest starting with simple maps and larger zones rather than very detailed maps [2].

IMPLEMENTERS
Wageningen University & Research with pilot arable and dairy farmers [1]

PROGRAMME AND FUNDING
Dutch agriculture ministry policy-support research (BO) [1]

PERIOD
2018–2021; second phase 2021–2026

SCALE
About 20 applications used by about 30 farmers, 2018–2021 [1]

TECHNOLOGY
Variable-rate task maps, band spraying, soil, biomass and satellite maps

TRANSFERABILITY TO TÜRKIYE
High

[1] Wageningen University & Research (2026). Nationale Proeftuin Precisielandbouw (BO-43-226-002, BO-43-120.01-004). Project record. https://research.wur.nl/en/projects/nationale-proeftuin-precisielandbouw-bo-43-226-002-bo-43-12001-00/

[2] van Tilburg, K., Wildeboer, S., van der Meer, A., Hollewand, F. (2026). NPPL-R: variabele technieken. Wageningen Plant Research, report WPR-OT-1193. https://doi.org/10.18174/708449

[3] Kempenaar, C., Been, T., Booij, J., van Evert, F., Michielsen, J.-M., Kocks, C. (2017). Advances in Variable Rate Technology Application in Potato in The Netherlands. Potato Research 60(3-4), 295-305. https://doi.org/10.1007/s11540-018-9357-4

FR
FRANCE

3.1.3 · SMART SOIL SENSORS AND FIELD ANALYTICS

Irrinov

Arvalis method that uses low-cost soil tension probes and a rain gauge to decide when to irrigate.

WHAT IT IS

Irrinov is an irrigation method developed by the French crop institute Arvalis in the 2000s [1]. Farmers install tensiometric probes at 30 and 60 cm and compare soil water tension with trigger thresholds set by soil type and crop stage [1]. It was first used on maize in two regions in 2002 [2]. Chambers of agriculture also issue irrigation warnings to all farmers based on reference plots [3].

HOW IT WORKS

- Usually six probes are installed per monitored plot, at 30 and 60 cm depth [1].
- Readings run from 0 centibar in saturated soil to 200 centibar in fully dry soil [1].
- Probes are read by hand every two to three days or logged automatically by a fixed unit [1].

RESULTS

€540

reader, ten probes, rain gauge and guides [2]

2003 price

12

soil types modelled in a connected digital version [4]

Weenat app, 2019

The soil-type figure is reported by the company.

No water-saving figures were found in the sources reviewed. Arvalis notes that the method uses indicators from a single pilot site of a few square metres per irrigation block [3].

WHY IT MATTERS FOR TÜRKIYE

Where water is scarce, as for irrigated maize, cotton and vegetables in provinces such as Şanlıurfa and Adana, Irrinov shows that a few cheap probes and clear thresholds can guide irrigation timing on small farms. One reference plot per area can also serve many farmers through bulletins.

TRANSFERABILITY

Probes are standard and inexpensive. Transfer depends on calibrating thresholds for Turkish soils and crops, and on cooperatives or extension services running reference plots and sending regular bulletins to farmers.

IMPLEMENTERS

Arvalis (method), chambers of agriculture (advice), sensor firms such as Weenat (digital version) [1,3,4]

PROGRAMME AND FUNDING

Technical institute method used in public advisory services; funding not documented

PERIOD

maize version since 2002 (earlier trials on cereals and peas)

SCALE

Maize from 2002, later more regions and potatoes [2,4]

TECHNOLOGY

Watermark tensiometric probes, rain gauge, threshold tables, optional wireless loggers

TRANSFERABILITY TO TÜRKIYE

High

[1] Chambre d'agriculture du Tarn (n.d.). Les outils d'aide au pilotage de l'irrigation: les sondes tensiométriques et capacitives. Factsheet. https://tarn.chambres-agriculture.fr/fileadmin/user_upload/284_chambre_dagriculture_-_tarn/Interface/PDF/Eau/sondes_tensio_cap.pdf

[2] Gloria, C. (2003). Irrinov Maïs s'adapte à deux nouvelles régions. Réussir Grandes Cultures (trade press), 21 October 2003. https://www.reussir.fr/grandes-cultures/irrinov-mais-sadapte-deux-nouvelles-regions

[3] Deumier, J.-M., Jacquin, C., Berrodier, M., Lacroix, B., Bouthier, A. (2008). La mise en œuvre de pratiques innovantes en vue de mieux valoriser la ressource en eau chez les agriculteurs. ARVALIS, Toulouse, 6 June 2008. https://ciag.hub.inrae.fr/content/download/3298/34466?version=1

[4] Pleinchamp (2019). Weenat développe son expertise dans l'irrigation de précision. Pleinchamp (trade press), 13 June 2019. https://www.pleinchamp.com/actualite/machinisme~weenat-developpe-son-expertise-dans-l-irrigation-de-precision

EU
EU-WIDE

3.1.3 · SMART SOIL SENSORS AND FIELD ANALYTICS

LUCAS Soil survey

EU-wide survey that samples topsoil at thousands of points and analyses the samples with harmonised methods.

WHAT IT IS

Eurostat runs the LUCAS land use survey with DG AGRI and technical support from the JRC [1]. Since 2009 a soil module has collected a topsoil sample at 10% of the survey points [2]. The 2022 round increased the sampling depth to 30 cm, aimed to double the fresh samples for soil biodiversity, assessed gully erosion and measured more metals and pesticide residues in a subset of samples [3].

HOW IT WORKS

- Surveyors collect about 0.5 kg of topsoil at selected points of the statistical grid [1].
- Laboratories measure pH, organic carbon, nitrogen, phosphorus, potassium and electrical conductivity, among other properties [4].
- The JRC licenses the data free of charge to registered users [4].

RESULTS

19,967
geo-referenced samples in 25 countries [1]
2009/2012 survey

18,984
topsoil samples with published data [4]
2018 survey

31,054
samples collected in all EU Member States [3]
2022 survey; data due 2027

The 2015 round also sampled Albania, Bosnia and Herzegovina, North Macedonia, Montenegro and Serbia with the same method [1]. The data support landscape-level diagnostics and policy rather than farm-level management.

WHY IT MATTERS FOR TÜRKIYE

Using the LUCAS protocol in Türkiye would make soil data from provinces such as Ankara or Şanlıurfa comparable with EU regions. This supports alignment with EU soil policy and gives advisers a baseline for organic carbon and nutrients, although it does not replace soil testing on each farm.

TRANSFERABILITY

The 2015 extension to Western Balkan countries shows that non-EU countries can be sampled with the same method [1]. Transfer needs a national sampling body, a reference laboratory and coordination with Eurostat and the JRC.

IMPLEMENTERS

Eurostat with DG AGRI and the Joint Research Centre (JRC) of the European Commission [1,2]

PROGRAMME AND FUNDING

European Commission statistical survey (LUCAS soil module) [2]

PERIOD

2009, 2015, 2018 and 2022

SCALE

31,054 samples in 2022, all EU Member States [3]

TECHNOLOGY

Standard field sampling, laboratory analysis, data free to registered users

TRANSFERABILITY TO TÜRKIYE

Medium

[1] JRC European Soil Data Centre (2026). LUCAS: Land Use and Coverage Area frame Survey. ESDAC. https://esdac.jrc.ec.europa.eu/projects/lucas
[2] Eurostat (2026). LUCAS: Methodology. European Commission. https://ec.europa.eu/eurostat/web/lucas/methodology
[3] JRC European Soil Data Centre (2026). LUCAS 2022 TOPSOIL data. ESDAC. https://esdac.jrc.ec.europa.eu/content/lucas-2022-topsoil-data
[4] JRC European Soil Data Centre (2022). LUCAS 2018 TOPSOIL data. ESDAC. https://esdac.jrc.ec.europa.eu/content/lucas-2018-topsoil-data

3.1 · REVIEW

Precision Agriculture: what the cases show

The strongest cases pair a simple, robust measurement with an organisation that turns data into advice: institutes and distributors for Farmstar, chambers of agriculture for Irrinov, a LIFE project for gaiasense and a research field lab for NPPL. Most savings figures are project- or company-reported rather than independently evaluated. Regulation and data access shape adoption, as the German drone and EU soil cases show.

CASE	COUNTRY	WHO USES IT	ENTRY COST / EFFORT	EVIDENCE	FIT FOR TÜRKIYE
Farmstar	France	Cereal and rapeseed farmers via 35 distributors	Paid service; needs locally calibrated crop models	Company scale figures; no independent savings data	Medium: cereals, dealer or cooperative delivery
Drone spraying in steep vineyards	Germany	Wine estates on steep slopes, licensed operators	Drone, tested nozzles, federal and state permits	2022 permits; peer-reviewed drift trials	Medium: sloping vineyards; needs national rules
LIFE GAIA Sense / gaiasense	Greece	Farmers and cooperatives, nine Mediterranean crops	Shared stations and advice; no costly farm equipment	Project-reported input cuts in 18 demonstrations	High: Mediterranean crops, cooperatives, small farms
NPPL field lab	Netherlands	Pilot arable and dairy farmers	Task-map-capable machines plus expert coaching	WUR reports; about 30% saving on one farm	High: field-lab model for pilot provinces
Irrinov	France	Irrigating farmers, chambers of agriculture	Kit about €540 at 2003 prices	Maize version since 2002; no saving figures found	High: water scarcity, low cost
LUCAS Soil survey	EU	Policy makers and researchers	Public survey; national sampling and laboratory needed	31,054 samples collected in 2022	Medium: route shown for non-EU countries

SUCCESS FACTORS

- A trusted institute or extension service owns the models and thresholds behind the advice.
- Advice reaches farmers through cooperatives, distributors or bulletins, not only through equipment purchases.
- Simple steps such as band spraying and larger map zones save inputs; cheap probes guide irrigation timing.
- Clear public rules and equipment testing make new technology, such as spraying drones, legally usable.

BARRIERS

- Few independent evaluations: most savings figures are project- or company-reported without stated baselines.
- Software and machine compatibility, file formats and time pressure defeat complex variable-rate maps on farms.
- Drone spraying needs product, equipment and site permits, and its area capacity is still limited.
- Models and thresholds need local calibration for soils, crops and climate before transfer.

3.1 · MORE EXAMPLES

Also worth knowing

Further documented practices in this theme, in brief.

SATELLITE DATA PORTAL (NETHERLANDS)

Since 2012 the Netherlands Space Agency's Satellite Data Portal has given users in the Netherlands free satellite images, now mainly high-resolution data bought by the Dutch government [1]. Since 2023 the paying agency RVO has used it to check anomalies in its CAP area monitoring [2]. An agri-supplier builds soil-potential maps from the archive [3].

GS-NETZ IRRIGATION APP (GERMANY)

An EIP-AGRI Operational Group led by Hochschule Geisenheim (2016–2018, Hesse rural development programme) developed GS-Mobil, a smartphone app for Geisenheim irrigation scheduling first prototyped in a 2012–2015 federal project, into a usable tool for lettuce and onion, with the weather service DWD, a software firm and farms [4,5]. No water-saving figure was published [5].

PLANTAR SENSORS (GERMANY, NETHERLANDS)

PLANtAR (from November 2020, 36 months), coordinated by Infineon with partners including Fraunhofer ENAS and Wageningen Research, developed screen-printed nitrate sensors and worked towards partly biodegradable sensor nodes [6,7]. The nitrate sensor gave accurate results over months, and a sensor was tested in a greenhouse at Bleiswijk [7]. No savings figures have been published.

[1] Netherlands Space Agency (2026). Over Satellietdataportaal. Satellietdataportaal. https://www.satellietdataportaal.nl/over-satellietdataportaal/

[2] Netherlands Space Agency (2026). Met satellietdata zorgen we dat landbouwsubsidie op de juiste plekken terechtkomt. Satellietdataportaal. https://www.satellietdataportaal.nl/met-satellietdata-zorgen-we-dat-landbouwsubsidie-op-de-juiste-plekken-terechtkomt/

[3] Netherlands Space Agency (2023). Waar groeien gewassen het best? Boeren besparen mest en water met satellietgegevens. Satellietdataportaal. https://www.satellietdataportaal.nl/bram-van-oers-specialist-precisielandbouw-bij-van-iperen-satellietdataportaal-was-katalysator-voor-onze-innovatie/

[4] EU CAP Network (2026). Implementation and further development of an online decision-support-system for an efficient irrigation scheduling of open field vegetable production. EIP-AGRI Operational Group. https://eu-cap-network.ec.europa.eu/projects/implementation-and-further-development-online-decision-support-system-efficient-irrigation_en

[5] Zinkernagel, J. (2020). Abschlussbericht GS-Netz. Hochschule Geisenheim, Institut für Gemüsebau; DVS. https://www.dvs-gap-netzwerk.de/fileadmin/sites/ELER/Datenbank/DOC_PDF/Abschlussbericht%20EIP-Netz-2020-06-09.pdf

[6] PLANtAR consortium (n.d.). PLANtAR: miniaturized monitoring sensor systems for plants and agriculture. Project factsheet, WUR eDepot. https://edepot.wur.nl/586918

[7] Schlagmann, M., Balendonck, J., Otto, T., Brandao Silva de Assis, M., Mertig, M., Hess, S. (2023). Development of sensor nodes and sensors for smart farming. Journal of Electrochemical Science and Engineering 13(5), 825-838. https://doi.org/10.5599/jese.1645

3.2

Smart Farming Technologies

This theme covers climate-smart control of protected cropping, and production units that run autonomously or recycle water and nutrients. The main cases come from the Netherlands and France, with further examples from Germany and Greece. They matter for Türkiye's greenhouse and irrigated regions, where energy, water and skilled labour set the limits.



Ankara: training of trainers on smart and precision farming under climate change and water scarcity, May 2026. AI-assisted illustration based on a real project photograph.

NL	Het Nieuwe Telen	3.2.1
FR	Crop-Steered Dynamic Agrivoltaics	3.2.1
NL	Autonomous Greenhouse Challenge	3.2.2
NL	Water-Efficient Emission-Free Greenhouse	3.2.2

NL
NETHERLANDS

3.2.1 · CLIMATE-SMART PROTECTED CROPPING

Het Nieuwe Telen

Greenhouse climate strategy that cuts heating energy by tuning screens, humidity and CO_2 to the crop.

WHAT IT IS

Het Nieuwe Telen (Next Generation Growing) was developed by Wageningen researchers with support from the Dutch agriculture ministry and the Horticultural Board, within the programme Kas als Energiebron [1]. The programme started in 2005 and is financed jointly by industry and government [2]. The crop is central: temperature, humidity and CO_2 are tuned to the plant's needs [2]. Several growers have worked this way since 2009 [2].

HOW IT WORKS

- Growers tune temperature, humidity and CO_2 to the crop's needs [2].
- More intensive use of energy screens and lower minimum heating-pipe temperatures save heating energy [3].
- Air circulation systems allow controlled exchange with drier outside air to remove excess humidity [3].

RESULTS

40–50%
less energy in research greenhouse trials, without production loss [1]
first results, research greenhouses, 2009–2010

10–20%
heating-energy saving potential on monitored commercial farms [3]
10 companies; WUR report 2015

1 m³
less gas equivalent per m² a year for each 1-point RH setpoint rise [4]
simulation model, cucumber growers

Monitoring of 10 commercial farms by Wageningen UR found that the saving potential is not always realised immediately; some farms showed a learning curve [3].

WHY IT MATTERS FOR TÜRKIYE

For heated greenhouses in Adana, İzmir and Antalya, every cut in heating energy lowers production costs. The approach relies on energy screens, humidity management and grower know-how, plus air circulation and dehumidification equipment. It also fits the project's training of young farmers in greenhouse climate management.

TRANSFERABILITY

Transfers best to glass or plastic greenhouses that already have screens and climate control. Advisory support and monitoring of pioneer farms are needed, because savings depend on grower learning. Joint public and sector funding helps adoption.

IMPLEMENTERS

Wageningen UR Greenhouse Horticulture researchers and Dutch growers, with support from the agriculture ministry (LNV) and the Horticultural Board [1]

PROGRAMME AND FUNDING

Kas als Energiebron (Greenhouse as Energy Source), financed jointly by government and industry [2]

PERIOD

Programme since 2005; growers applying it since 2009 [2]

SCALE

10 commercial greenhouse companies monitored against a chosen reference [3]

TECHNOLOGY

Energy screens, air circulation with outside-air dehumidification, temperature and humidity monitoring

TRANSFERABILITY TO TÜRKIYE

Medium

[1] Wageningen UR (2010). Kasteelt kan helft zuiniger. Kennis Online, August 2010. https://edepot.wur.nl/168551

[2] Kas als Energiebron (2011). Kas als Energiebron: voor een krachtige klimaatneutrale glastuinbouw. Factsheet, October 2011. https://edepot.wur.nl/298236

[3] de Zwart, F., Raaphorst, M., van Weel, P., Speetjens, B., Janssen, H., Verkerke, W. (2015). Monitoring Energiebesparing en Teeltervaringen bij Energie-innovaties. Report GTB-1357, Wageningen UR Glastuinbouw. https://edepot.wur.nl/347930

[4] de Zwart, H.F., Raaphorst, M. (2017). Intensief schermen en energiezuinig ontvochtigen met Het Nieuwe Telen in komkommer. Report GTB-1444, Wageningen Plant Research. https://doi.org/10.18174/417313

FR
FRANCE

3.2.1 · CLIMATE-SMART PROTECTED CROPPING

Crop-Steered Dynamic Agrivoltaics

Tilting solar panels over crops, steered by crop models and sensors to shade or light plants as needed.

WHAT IT IS

In dynamic agrivoltaics, solar louvres above the crop tilt to give sun or shade, steered by algorithms designed around the plant's needs [1]. Montpellier research with Sun'R measured crop water use under solar panel prototypes at two panel densities [2] and modelled it under tilting panels [3]. Sun'Agri, with INRAE and the Pyrénées-Orientales Chamber of Agriculture, compared crop-led steering with full solar tracking on a 4.5 ha vineyard at Tresserre, 2018–2024 [4].

HOW IT WORKS

- Weather stations and connected irrigation meters report in real time to the panel control system [1].
- At Tresserre, shading has been optimised with a grapevine crop model since 2022 [4].
- Panels can be steered for the crop or for maximum electricity, and the two goals conflict [4].

RESULTS

−10–30%
evapotranspiration under panels at 50–70% of full sun [2]
irrigated lettuce and cucumber

+61%
Chardonnay yield vs control, crop-led steering, 2024 drought [4]
Grenache Blanc +31%, Marselan +18%

−45%
maximum yield loss vs control under electricity-led tracking [4]
Tresserre, 2023 and 2024

Vineyard figures reported by Sun'Agri with the regional Chamber of Agriculture (conference abstract).

A model study suggests irrigation could fall by 20% if a 10% yield decrease is accepted [3]. The first harvest (2022) was lower under the panels, attributed to manual planting and soil compaction [4].

WHY IT MATTERS FOR TÜRKIYE

Water scarcity and summer heat put pressure on irrigated vineyards, orchards and vegetables in provinces such as İzmir and Adana. Crop-led shading could lower irrigation demand while producing electricity, provided panels are steered for the crop first. A cooperative pilot could test this locally.

TRANSFERABILITY

Needs a grid connection, clear rules for agrivoltaics and investment partners, typically through cooperatives. Best suited to high-value perennial crops, with steering rules that give the crop priority over electricity output.

IMPLEMENTERS

INRA Montpellier researchers with Sun'R [2]; Sun'Agri with INRAE and the Pyrénées-Orientales Chamber of Agriculture (CA66) [4]

PROGRAMME AND FUNDING

Sun'Agri I, II and III research programmes, supported by ADEME (company-reported) [1]

PERIOD

Concept since 2009 [1]; Tresserre vineyard monitored 2018–2024 [4]

SCALE

Tresserre vineyard 4.5 ha plus 3 ha control [4]; Claira vineyard 2.9 ha [1]

TECHNOLOGY

Tilting PV louvres, crop models, weather stations, connected irrigation meters

TRANSFERABILITY TO TÜRKIYE

Medium

[1] Sun'Agri (2023). Dossier de presse: installation agrivoltaïque sur vignes à Claira (66). Company press kit, AREC Occitanie. https://www.arec-occitanie.fr/sites/default/files/dossier_de_presse_claira_sunagri.pdf

[2] Marrou, H., Dufour, L., Wéry, J. (2013). How does a shelter of solar panels influence water flows in a soil-crop system? European Journal of Agronomy 50: 38–51. https://doi.org/10.1016/j.eja.2013.05.004

[3] Elamri, Y., Cheviron, B., Lopez, J.-M., Dejean, C., Belaud, G. (2018). Water budget and crop modelling for agrivoltaic systems: application to irrigated lettuces. Agricultural Water Management 208: 440–453. https://doi.org/10.1016/j.agwat.2018.07.001

[4] Fumey, D. et al. (2025). Pioneering dynamic AgriVoltaics in viticulture: enhancing grapevine productivity, wine quality and climate protection through agronomical steering in a large-scale field study. GiESCO 2025, IVES Conference Series. https://ives-openscience.eu/55373/

NL
NETHERLANDS

3.2.2 · AUTONOMOUS AND CLOSED-LOOP PRODUCTION UNITS

Autonomous Greenhouse Challenge

International contest in which AI algorithms remotely run Wageningen greenhouse compartments, compared with a reference team.

WHAT IT IS

Wageningen University & Research runs an international challenge in which teams with backgrounds in AI and horticulture operate greenhouse compartments remotely [1]. Their algorithms use sensor data to set climate and crop strategies, with the goal of the highest net profit [1]. Editions have covered cucumber in 2018, cherry tomato in 2019–2020, lettuce, and dwarf tomato in autumn 2024 [1,2,3].

HOW IT WORKS

- Setpoints and measured data are exchanged every 5 minutes between team algorithms and the greenhouse [1].
- Daily data include heating energy, electricity, CO_2 dosage and water use per square metre [1].
- Drain water is collected [1,3]; in 2019–2020 one compartment was run by human reference growers [1].

RESULTS

€6.86/m²
net profit of the best AI team; human growers €3.10/m² [1]
cherry tomato, December 2019 to May 2020

12.9 MJ/kg
heat per kg tomato, best AI team; human growers 33.0 MJ/kg [1]
same edition

45 kg/m²
annualised yield of the best 2024 algorithm; reference team 35 kg/m² [3]
dwarf tomato, autumn 2024

In 2020 all AI-supported teams outperformed the human reference, but none ran fully autonomously: all teams kept humans in the decision loop [1].

WHY IT MATTERS FOR TÜRKIYE

Greenhouse regions such as Antalya, Adana and İzmir need managers who can work with climate data and remote control. A regional challenge run by a Turkish university, with open data and a human reference, would train young agronomists and test remote management under Mediterranean conditions before farms invest.

TRANSFERABILITY

Replicable by a university or research station with four to six instrumented compartments and sponsors. Commercial use needs reliable sensors and connectivity; in 2024 algorithms made all operational decisions for two months, but staff still handled the crop [3].

IMPLEMENTERS

Wageningen University & Research, Business Unit Greenhouse Horticulture, with international teams in each edition [1]

PROGRAMME AND FUNDING

Private sponsorship; the 2019–2020 edition was funded by Tencent [1]

PERIOD

2018–2024, four editions

SCALE

Six compartments of 96 m² each at WUR Bleiswijk [1]

TECHNOLOGY

Sensors, cameras, crop models and AI algorithms setting climate and irrigation remotely

TRANSFERABILITY TO TÜRKIYE

Medium

[1] Hemming, S., de Zwart, F., Elings, A., Petropoulou, A., Righini, I. (2020). Cherry Tomato Production in Intelligent Greenhouses: Sensors and AI for Control of Climate, Irrigation, Crop Yield, and Quality. Sensors 20(22): 6430. https://doi.org/10.3390/s20226430

[2] Petropoulou, A.S., van Marrewijk, B., de Zwart, F., Elings, A., Bijlaard, M., van Daalen, T., Jansen, G., Hemming, S. (2023). Lettuce Production in Intelligent Greenhouses: 3D Imaging and Computer Vision for Plant Spacing Decisions. Sensors 23(6): 2929. https://doi.org/10.3390/s23062929

[3] Maree, S.C. et al. (2025). Autonomous Greenhouse Cultivation of Dwarf Tomato: Performance Evaluation of Intelligent Algorithms for Multiple-Sensor Feedback. Sensors 25(14): 4321. https://doi.org/10.3390/s25144321

NL
NETHERLANDS

3.2.2 · AUTONOMOUS AND CLOSED-LOOP PRODUCTION UNITS

Water-Efficient Emission-Free Greenhouse

Demonstration showing that a fully closed water and nutrient loop in soilless sweet pepper keeps yield and quality.

WHAT IT IS

Wageningen UR Greenhouse Horticulture and partners closed the water cycle at farm level in test greenhouses in Bleiswijk [1]. A conventional system with regular discharge was compared with an emission-free one, aiming at equal yield and quality [1]. Cucumber was grown in autumn 2014, then sweet pepper on rockwool from December 2014 to November 2015, with ozone disinfection of the recirculated water [1].

HOW IT WORKS

- Rainwater is disinfected before use, and drip irrigation is supplied through a ring main [1].
- The first drain water is reused instead of discharged, and the filter works without rinse water [1].
- Weekly nutrient analysis adjusts the feed; five weeks before crop end the solution is changed to use up stocks [1].

RESULTS

Zero
drain-water discharge from the emission-free system [1]
sweet pepper, December 2014 to November 2015

27.4 kg/m²
sweet pepper yield, against 26.3 kg/m² in the conventional system [1]
quality comparable

152 kg N/ha
discharged per year by the conventional system, above the 133 kg norm [1]
4% of water discharged

Water use was higher in the emission-free crop (897 against 796 l/m²), attributed to taller plants with more leaf; recoverable condensate was not counted [1]. Dutch rules now require condensate reuse and good irrigation water for recirculation [2].

WHY IT MATTERS FOR TÜRKIYE

Soilless greenhouses around Antalya, Adana and İzmir that discharge drain water lose both water and fertiliser and add nitrate to groundwater. The measures shown are mostly organisational and affordable, so cooperatives could pilot them with a shared laboratory, cutting fertiliser costs and protecting scarce water.

TRANSFERABILITY

Feasible for substrate growers with a disinfection unit (UV or ozone) and access to weekly nutrient analysis. The Dutch path from sector agreement to emission norms to obligations offers a model for dialogue with water authorities.

IMPLEMENTERS

Wageningen UR Greenhouse Horticulture and Groen Agro Control, with a consortium of supplier companies [1]

PROGRAMME AND FUNDING

EU ERDF (EFRO), Top Sector Horticulture, Province of South Holland and STOWA [1]

PERIOD

2014–2015 (report 2016)

SCALE

Two greenhouse compartments of 120 m² net each, Bleiswijk [1]

TECHNOLOGY

Drain-water recirculation, ozone disinfection, rainwater disinfection, weekly nutrient analysis

TRANSFERABILITY TO TÜRKIYE

High

[1] van Os, E., van Ruijven, J., Janse, J., Beerling, E., van der Staaij, M., Kaarsemaker, R. (2016). Vergelijking tussen gangbaar en emissieloos teeltsysteem: Waterefficiënte Emissieloze Kas. Report GTB-1406, Wageningen Plant Research. https://edepot.wur.nl/394562

[2] Wageningen Research (2026). Routekaart Emissieloos telen in de glastuinbouw. Route and opportunity map for TKI Tuinbouw en Uitgangsmaterialen. https://edepot.wur.nl/712748

3.2 · REVIEW

Smart Farming Technologies: what the cases show

The verified cases show that climate control and water management pay off when they serve a clear agronomic goal: less heating energy, less irrigation or a closed nutrient loop. On-farm monitoring gives more modest figures than research trials, and steering for electricity or full autonomy brings trade-offs. Knowledge, advisory support and joint public and sector funding matter as much as hardware.

CASE	COUNTRY	WHO USES IT	ENTRY COST / EFFORT	EVIDENCE	FIT FOR TÜRKIYE
Het Nieuwe Telen	Netherlands	Commercial greenhouse growers	Medium: screens, air circulation and dehumidification units, advice	WUR monitoring of 10 commercial farms	High for heated greenhouses
Crop-steered dynamic agrivoltaics	France	Vineyard and vegetable growers with energy partners	High: PV structure, grid connection, investors	Peer-reviewed water data; company-reported vineyard yields	Medium: water-scarce Aegean and Mediterranean areas
Autonomous Greenhouse Challenge	Netherlands	Research institutes, AI teams, greenhouse sector	Medium: instrumented compartments, data platform, sponsors	Peer-reviewed results from three editions	Medium: training and research tool
Water-efficient emission-free greenhouse	Netherlands	Soilless greenhouse growers	Medium: disinfection unit, weekly nutrient analysis	Demonstration trial, WUR report	High for soilless greenhouses

SUCCESS FACTORS

- Clear agronomic targets (energy, water, nutrients) guide how sensors and algorithms are used.
- Monitoring on pioneer farms builds grower confidence and shows realistic savings.
- Joint funding by government, the sector and EU funds lowers the risk of early trials.
- Open competitions and shared data make results comparable and train new specialists.

BARRIERS

- Savings depend on grower learning; installed systems do not always deliver at once.
- Capital-intensive set-ups such as agrivoltaic structures need investors or cooperatives.
- Optimising for electricity output or automation can conflict with crop yield.
- Full autonomy is still experimental: in 2024 algorithms made all operational decisions, but staff did the crop work.

3.2 · MORE EXAMPLES

Also worth knowing

Further documented practices in this theme, in brief.

ZINEG LOW-ENERGY GREENHOUSE INITIATIVE (GERMANY)

Research project (2009–2014) funded by German federal ministries and the Rentenbank [1], coordinated by Leibniz University Hanover [2]. A semi-closed solar-collector greenhouse in Berlin raised tomato yield by 32%; energy use efficiency rose 103% counting the greenhouse as an energy producer [3]. The Hannover greenhouse aimed at energy savings of up to 90% [1].

HYDROUSA WATER LOOPS (GREECE)

Horizon 2020 project (2018–2023, EU contribution €9.96 million) coordinated by the National Technical University of Athens, with six full-scale water-loop sites on Lesvos, Mykonos and Tinos [4,5]. It verified class A reclaimed water for unrestricted irrigation and showed that fertigation can eliminate inorganic fertilisers [5]. Payback periods ranged from 3.5 to 8.2 years [5].

[1] Tantau, H.-J., Achilles, W., Schmidt, U. et al. (2015). Niedrigenergiegewächshäuser: Ergebnisse des ZINEG-Verbundprojektes. KTBL-Schrift 509, KTBL. https://www.ktbl.de/fileadmin/produkte/leseprobe/11509excerpt.pdf

[2] ATB (2015). German Sustainability Award Research 2014 for the low energy green house ZINEG. Leibniz Institute for Agricultural Engineering and Bioeconomy. https://atb-potsdam.de/en/news-and-press/news/news-details/german-sustainability-award-research-2014-for-the-low-energy-green-house-zineg-partner-in-the-project-atb

[3] Dannehl, D., Schuch, I., Schmidt, U. (2013). Plant Production in Solar Collector Greenhouses: Influence on Yield, Energy Use Efficiency and Reduction in CO2 Emissions. Journal of Agricultural Science 5(10): 34. https://doi.org/10.5539/jas.v5n10p34

[4] CORDIS (2023). HYDROUSA: Demonstration of water loops with innovative regenerative business models for the Mediterranean region. Grant 776643, European Commission. https://cordis.europa.eu/project/id/776643

[5] CORDIS (2024). HYDROUSA: Periodic Reporting for period 3 (2021–2023), results summary. European Commission. https://cordis.europa.eu/project/id/776643/reporting

3.3

Farm Data Management

Farm data now moves between machines, software, buyers, advisors and public bodies. This theme shows how Germany, the Netherlands, France and EU associations keep that flow under farmer control: neutral exchange platforms, public data portals, cooperative consent services and contract codes. These matter most for small farms, which lack power to negotiate data terms.



Adapazarı (Sakarya): field visit during young farmers' training, June 2026. AI-assisted illustration based on a real project photograph.

DE	agrirouter	3.3.1
DE	GeoBox infrastructure	3.3.1
NL	JoinData	3.3.2
NL	Akkerweb and farmmaps	3.3.2
FR	Data-Agri charter and label	3.3.3
EU	EU Agricultural Data Code	3.3.3

DE
GERMANY

3.3.1 · GOVERNMENT-SUPPORTED DATA INTEGRATION (GERMANY)

agrirouter

Manufacturer-neutral platform that routes data between farm machines and software under the farmer's control.

WHAT IT IS

agrirouter is a web-based platform that lets farm machines and agricultural software from different manufacturers exchange data [1]. DKE-Data launched it at the SIMA fair in 2019; the company's shareholders are machinery manufacturers, each with one vote [1]. The platform acts as a neutral hub: no data moves between connected systems unless the farmer or contractor has set up a route for it [2].

HOW IT WORKS

- Farmers open a free account and set routes stating who may exchange which data with whom [1,2].
- App and machine providers connect to its interface; app providers are billed for the data volume transported and received [1].
- In 2026 it added two-way data exchange with the John Deere Operations Center [3].

RESULTS

100+
partners in the agrirouter network [4]

5,500
users, with about 100 to 150 joining each month [4]
after the 2024 relaunch

7.4 million
telemetry messages in the first month of version 2.0 [4]
3.5 million a year earlier

Figures reported by the company.

No independent evaluation of farm-level benefits has been published.

WHY IT MATTERS FOR TÜRKIYE

Where Turkish farms and contractors run machines of several brands, data tends to stay locked in each maker's system. A neutral, farmer-routed exchange layer would let cooperatives, advisors and contractors in pilot provinces such as Adana or Şanlıurfa receive field and machine data only with the farmer's consent.

TRANSFERABILITY

Turkish software and machinery firms could join DKE-Data as partners and connect their products. A national equivalent would need a manufacturer consortium, a fair fee model and simple route setup for farmers.

IMPLEMENTERS

DKE-Data GmbH & Co. KG (Osnabrück), a non-profit company owned by machinery manufacturers (eleven in 2019) [1]

PROGRAMME AND FUNDING

Owned by machinery manufacturers; free accounts for farmers, app providers pay per data volume [1]

PERIOD

Launched 2019 (company founded 2016)

SCALE

Over 100 partners and about 5,500 users [4]

TECHNOLOGY

Cloud message hub with one API; farmer-defined routes between endpoints

TRANSFERABILITY TO TÜRKIYE

Medium

[1] Amazone (2019). SIMA 2019: The agrirouter is online. Press release, Amazonen-Werke. https://amazone.net/en/service-support/for-the-press/press-releases/press-archive-2019-/sima-2019-the-agrirouter-is-online-44730

[2] DKE-Data (2026). agrirouter Developer Docs: Ecosystem. DKE-Data GmbH & Co. KG. https://agrirouter.com/en/docs/concepts/ecosystem

[3] DKE-Data (2026). John Deere Operations Center and agrirouter: bidirectional, cross-manufacturer data exchange is finally possible. agrirouter news. https://agrirouter.com/en/news/2026-09-18-bidirectional-data-exchange-john-deere-agrirouter

[4] HiveMQ (2024). Case study: DKE-Data sets new standard for agricultural connectivity with HiveMQ and Reply. HiveMQ. https://www.hivemq.com/case-studies/dke-data/

DE
GERMANY

3.3.1 · GOVERNMENT-SUPPORTED DATA INTEGRATION (GERMANY)

GeoBox infrastructure

State-run online viewer that brings official farm-relevant data from many authorities onto one map.

WHAT IT IS

The GeoBox-Viewer, in practical use since 2018, gives farmers one online access point where all freely available farm-relevant data can be viewed together in real time [1]. It draws on the server infrastructure of various state authorities [1]. In 2021 Brandenburg, Hesse, North Rhine-Westphalia, Schleswig-Holstein and Saarland signed an agreement with Rhineland-Palatinate to run the infrastructure jointly, with cost shares of about €200,000 a year [1].

HOW IT WORKS

- One map shows official layers from several agencies; the DLR technical centre runs it for all partner Länder [1].
- A messenger, described by the ministry as GDPR-compliant, has carried DLR advisory channels in test operation since 2021 [1].
- Two rounds of focus groups shaped an offline-capable, decentralised design, later evaluated with 16 practitioners [2].

RESULTS

6
Länder in the 2021 joint operating agreement [1]

€200,000
annual cost shares for running the viewer for partner Länder [1]

67
practitioners in two rounds of design focus groups (15 and 52) [2]
2017 and 2019

Viewer pages for seven Länder were online in October 2026 [3]. The ministry plans to let farms pass their state-sourced data to service providers under their own control [1]. No user numbers have been published.

WHY IT MATTERS FOR TÜRKIYE

Where parcel, soil, water and support data sit with different public bodies, a single public viewer shared by several provinces with agreed cost shares could give small farms in Sakarya or İzmir their official field data in one place and prepare consent-based sharing with advisors and cooperatives.

TRANSFERABILITY

Transfer needs a lead ministry or provincial directorate with GIS capacity, agreements with data-holding agencies to serve their layers live, and a cost-sharing rule between regions; no new farm hardware is required.

IMPLEMENTERS

Rhineland-Palatinate agriculture ministry; run by the DLR Rheinhessen-Nahe-Hunsrück technical centre; five more Länder share costs [1]

PROGRAMME AND FUNDING

Länder cost shares; GeoBox-II research funded by the federal Special Purpose Fund at Rentenbank [2]

PERIOD

Viewer since 2018; six-Land agreement 2021

SCALE

Six Länder in the 2021 agreement; viewer pages for seven Länder online [1,3]

TECHNOLOGY

Web map viewer on agencies' own servers, advisory messenger, on-farm Hofbox prototype

TRANSFERABILITY TO TÜRKIYE

High

[1] Ministerium für Wirtschaft, Verkehr, Landwirtschaft und Weinbau Rheinland-Pfalz (2022). Sprechvermerk, Ausschuss für Landwirtschaft und Weinbau, 10 March 2022, Vorlage 18/1672. Landtag Rheinland-Pfalz. https://dokumente.landtag.rlp.de/landtag/vorlagen/1672-V-18.pdf

[2] Kuntke, F., Kaufhold, M.-A., Linsner, S., Reuter, C. (2023). GeoBox: design and evaluation of a tool for resilient and decentralised data management in agriculture. Behaviour & Information Technology. https://doi.org/10.1080/0144929X.2023.2185747

[3] GeoBox-Viewer (2026). Viewer pages for Rhineland-Palatinate, Brandenburg, Hesse, North Rhine-Westphalia, Schleswig-Holstein, Saarland and Saxony-Anhalt. geobox-i.de. https://www.geobox-i.de/GBV-RLP/

NL NETHERLANDS

3.3.2 · OPEN DATA AND GROWER COOPERATIVES (NETHERLANDS)

JoinData

Non-profit cooperative platform where farmers grant, review and revoke permissions to use their farm data.

WHAT IT IS

JoinData is an independent, non-profit data platform for Dutch farmers and growers, started as a cooperative in 2017 out of the Smart Dairy Farming initiative [1]. Companies that want a farmer's data, such as accountants, feed suppliers or dairy firms, must request permission through the platform [2]. Each request states its purpose, and the farmer can approve it or revoke it later at the press of a button [2].

HOW IT WORKS

- Farmers log in once and see all current permissions of their suppliers and buyers in one overview [2].
- JoinData forwards sealed data like a post office and does not look inside [2].
- An independent audit committee, a farmers' sounding board and ISO 27001 certification support trust [3].

RESULTS

9,000
farmers (almost) logged in to the new Mijn JoinData portal [4]
April to December 2022

490,000
active data permissions (almost) [4]
over 15,000 revoked

260
data suppliers connected to the platform [4]
December 2022

Figures reported by the organisation.

Almost 10 million messages passed through the platform in 2022 [4]. No later official totals were found.

WHY IT MATTERS FOR TÜRKIYE

Turkish dairy and sugar beet cooperatives could play JoinData's role between farmers, buyers, banks and public bodies. A cooperative-owned consent platform would let members see and revoke who uses their data, building the trust that young farmers need before they adopt digital tools.

TRANSFERABILITY

Works where cooperatives already handle member data. It needs a neutral legal entity, farmer and data advisory boards, an audit committee, a small annual fee and alignment with KVKK data protection rules.

IMPLEMENTERS

JoinData U.A., a non-profit cooperative founded in 2017 by CRV, FrieslandCampina, Agrifirm, LTO Nederland and EDI-Circle; Rabobank, Cosun and Avebe joined later [1]

PROGRAMME AND FUNDING

Fees: farmers pay €56.76 a year, data users pay for data transport [2]

PERIOD

Since 2017

SCALE

Almost 9,000 farmers logged in; almost 490,000 active permissions (2022) [4]

TECHNOLOGY

Web portal with eHerkenning login; sealed, purpose-bound data delivery

TRANSFERABILITY TO TÜRKIYE

High

[1] JoinData (2026). Over JoinData. JoinData U.A. https://join-data.nl/over-joindata/
[2] JoinData (2026). Wat we doen: jouw machtigingen bij JoinData. JoinData U.A. https://join-data.nl/wat-we-doen/
[3] JoinData (2026). Organisatie: hoe is JoinData opgebouwd? JoinData U.A. https://join-data.nl/organisatie/
[4] JoinData (2022). JoinData in cijfers en feiten. JoinData U.A. https://join-data.nl/nieuws/joindata-in-cijfers-en-feiten/

NL NETHERLANDS

3.3.2 · OPEN DATA AND GROWER COOPERATIVES (NETHERLANDS)

Akkerweb and farmmaps

Open precision-farming platform that combines public geodata, farm data and science-based advice apps.

WHAT IT IS

Wageningen University & Research and the farmers' cooperative Agrifirm Plant began developing Akkerweb in 2010; by 2016 they judged it mature enough to launch on the Dutch market as an open service platform for precision agriculture [1]. Growers open a free account to manage public and private data, monitor crops and make variable-rate prescription maps [1]. Its next version, farmmaps, became available in 2021 and was still online in 2026 [1,2].

HOW IT WORKS

- Free base services include background maps, government crop parcels, weather data, satellite images and soil maps [1].
- Science-based models, such as late blight and potato growth, are offered as apps and APIs [1].
- Data remain the grower's property; farmmaps connects to farm software and agrirouter [1,2].

RESULTS

5,000+

users, mainly Dutch arable farmers, farm advisors and researchers [1]

30+

apps on the Akkerweb platform [1]

User and app numbers reported by the platform developers (2023).

The developers estimate that less than 1% of Dutch farms are mature data-driven farms, and see ease of use and trust through good governance as crucial [1]. No farm-level outcome figures have been published.

WHY IT MATTERS FOR TÜRKIYE

A research institute and cooperative partnership like Akkerweb could turn Türkiye's public parcel, weather and satellite data into free starter maps for growers in Adana or Sakarya. Irrigation and disease models calibrated for local crops and water limits would make it a practical tool for advisors and farmer training.

TRANSFERABILITY

Needs a research partner to maintain and calibrate models, access to public parcel and satellite data, a neutral foundation to own the platform, and a cooperative to bring growers and advisors on board.

IMPLEMENTERS

Wageningen University & Research with the cooperative Agrifirm Plant; software by DOBS; now owned by a WUR foundation [1]

PROGRAMME AND FUNDING

Not-for-profit foundation; free basic account, free and commercial apps [1]

PERIOD

Developed from 2010; market-ready by 2016; farmmaps since 2021

SCALE

Over 5,000 users and more than 30 apps (developers' figures, 2023) [1]

TECHNOLOGY

Cloud geo-platform, satellite and weather services, crop models, task-map generator

TRANSFERABILITY TO TÜRKIYE

Medium

[1] Been, T.H., Kempenaar, C., van Evert, F.K. et al. (2023). Akkerweb and farmmaps: Development of Open Service Platforms for Precision Agriculture. In Precision Agriculture: Modelling, Springer. DOI 10.1007/978-3-031-15258-0_16. https://edepot.wur.nl/590402

[2] FarmMaps (2026). About FarmMaps. FarmMaps. https://www.farmmaps.net/en/

FR
FRANCE

3.3.3 · DATA SECURITY AND ANALYTICS FOR SMALL AND MID-SIZED FARMS

Data-Agri charter and label

Farmer-union charter and audited label for companies whose contracts respect 13 farm-data principles.

WHAT IT IS

Data-Agri is a charter and a label created by the French farmers' unions FNSEA and Jeunes Agriculteurs (young farmers) [1]. The label goes to companies that collect farm data and respect all 13 principles of the charter presented in April 2018 [1]. The principles include a written contract, transparent storage and purposes, data portability, explicit and revocable consent, and prior consent before any third-party use [2].

HOW IT WORKS

- A company can first take a ten-question self-test, then submits its contracts for labelling [2].
- An independent trusted third party audits the contracts and gives Data-Agri a positive or negative opinion [2].
- The label is granted for three years, and labelled companies are shown on the website [1,2].

RESULTS

13
principles in four areas: readability, transparency, control, security [2]

4
first labels, awarded at the SIMA fair in Paris [1]
February 2019

8
labelled companies listed on the Data-Agri website [2]
October 2026

No figures on farmer uptake or on effects for farms have been published.

WHY IT MATTERS FOR TÜRKIYE

As apps, input suppliers and machinery dealers collect more field data in Türkiye, farmers need contracts that say who may reuse it. A label run by farmer organisations, with young farmers as co-owners, protects smallholders through contract terms rather than costly infrastructure and can reference KVKK data protection rules.

TRANSFERABILITY

Needs a farmer organisation willing to own the label, a law firm or university to audit contracts, a modest fee for applicants and a public list of labelled firms; the principles can be adapted to KVKK.

IMPLEMENTERS

FNSEA and Jeunes Agriculteurs, through the association ENUMA; contracts audited by an independent third party [1,2]

PROGRAMME AND FUNDING

Farmer-organisation initiative; companies pay labelling fees [2]

PERIOD

Charter April 2018; labels since 2019

SCALE

Eight labelled companies listed in October 2026 [2]

TECHNOLOGY

None: contract audit against 13 principles, plus a ten-question self-test

TRANSFERABILITY TO TÜRKIYE

High

[1] FNSEA and Jeunes Agriculteurs (2019). Data-Agri : quatre premiers labels attribués lors du SIMA. Press release. https://www.jeunes-agriculteurs.fr/wp-content/uploads/2019/03/190308_cp_data_agri_fnsea_ja.pdf

[2] Data-Agri (2026). Valoriser et sécuriser les données des exploitations agricoles dans les contrats (principles, labelling, labelled companies). FNSEA and JA. https://www.data-agri.fr/

EU
EU-WIDE

3.3.3 · DATA SECURITY AND ANALYTICS FOR SMALL AND MID-SIZED FARMS

EU Agricultural Data Code

Voluntary contract guidelines from EU agri-food associations on who may access and use farm data.

WHAT IT IS

The EU Code of Conduct on agricultural data sharing by contractual agreement was agreed in 2018 by nine EU associations of the agri-food chain, including Copa-Cogeca, the young farmers' council CEJA and the machinery association CEMA [1]. It is non-binding guidance that mainly covers non-personal data [2]. It gives the data originator, often the farmer, a leading role in controlling access and a right to benefit from the data [2].

HOW IT WORKS

- Contracts should set out data use clearly; no party may use or share data without the originator's consent [2].
- Originators should be free to move their data to other platforms unless the contract states otherwise [2].
- Data users should protect databases, pseudonymise personal data and give a contact point for complaints [2].

RESULTS

11

EU associations co-signing the Code [3]

nine at the 2018 launch

No figures on uptake by individual companies have been published. Because it is voluntary, the Code may not guarantee data portability in practice; the EU Data Act now sets binding rules [4].

WHY IT MATTERS FOR TÜRKIYE

Turkish farmer unions, cooperatives, input suppliers and machinery dealers could use the Code as a ready model text, translated and adapted to KVKK. For exporters and EU-funded projects in the pilot provinces, aligning contracts with the Code and the EU Data Act would reduce friction with European partners.

TRANSFERABILITY

The text is free to reuse and translate. Real effect needs a Turkish signatory group, a public register of companies applying it and some checking, as the French label (audit) and the Dutch code (register) show.

IMPLEMENTERS

Copa-Cogeca, CEMA, CEJA, Fertilizers Europe, CEETTAR, ECPA, EFFAB, FEFAC, ESA; later AnimalHealthEurope and CLIMMAR [1,3]

PROGRAMME AND FUNDING

Industry self-regulation, prepared with assistance from the European Commission [2]

PERIOD

Since 2018

SCALE

11 co-signing EU associations [3]

TECHNOLOGY

None: non-binding contract principles and a contract checklist

TRANSFERABILITY TO TÜRKIYE

High

[1] CEMA (2018). How to share agricultural data? EU Code of Conduct on agricultural data sharing by contractual agreement. CEMA. https://cema-agri.org/digital-farming/43-digital-farming/89-how-to-share-agricultural-data-eu-code-of-conduct-on-agricultural-data-sharing-by-contractual-agreement

[2] Copa-Cogeca, CEMA, Fertilizers Europe, CEETTAR, CEJA, ECPA, EFFAB, FEFAC, ESA (2018; English edition 2020). EU Code of conduct on agricultural data sharing by contractual agreement. https://www.cema-agri.org/images/publications/brochures/EU_Code_of_conduct_on_agricultural_data_sharing_by_contractual_agreement_2020_ENGLISH.pdf

[3] CEMA (2018). EU Code of Conduct on agricultural data sharing (publication page). CEMA. https://cema-agri.org/publication/brochures/37-eu-code-of-conduct-on-agricultural-data-sharing

[4] Ryan, M., Bizot-Espiard, M. et al. (2024). Design principles and guidelines for agricultural data spaces based on legislation and ethical principles. AgriDataSpace CSA deliverable, Digital Europe Programme. https://edepot.wur.nl/713321

3.3 · REVIEW

Farm Data Management: what the cases show

The cases show two routes to farmer control of data. Infrastructure routes (agrirouter, GeoBox, JoinData, farmmaps) move data between systems and need a neutral operator with stable funding. Governance routes (Data-Agri, the EU Code) set contract rules at low cost but depend on checking. The strongest examples combine both: farmer-governed operators, consent tied to a purpose, and costs carried mainly by data users or public budgets.

CASE	COUNTRY	WHO USES IT	ENTRY COST / EFFORT	EVIDENCE	FIT FOR TÜRKIYE
agrirouter	Germany	Farmers, contractors, machine and software providers	Free for farmers; providers pay per data volume	About 5,500 users, 100+ partners (company-reported)	High where fleets mix brands
GeoBox infrastructure	Germany	Farms in Rhineland-Palatinate and partner Länder	Public service; Länder share about €200,000 a year	Ministry report; peer-reviewed design study	High for scattered official geodata
JoinData	Netherlands	Dutch farmers and about 260 data suppliers	€56.76 a year per farmer; data users pay transport	Almost 9,000 farmers logged in (2022, self-reported)	High through dairy, sugar and feed cooperatives
Akkerweb and farmmaps	Netherlands	Arable farmers, advisors and researchers	Free account; some commercial apps	Over 5,000 users (developers' figure); Springer book chapter	Medium: models need local calibration
Data-Agri charter and label	France	Companies collecting data from French farms	Audit and labelling fees paid by companies	Eight labelled companies; no farmer-level figures	High: low cost, led by farmer unions
EU Agricultural Data Code	EU-wide	EU agri-food associations and their members	Free text; voluntary self-regulation	11 co-signatories; uptake not measured	High as a template for contracts

SUCCESS FACTORS

- Neutral operators: non-profit or public bodies run the service, not a single vendor or buyer.
- Consent is tied to a stated purpose, and farmers can review and revoke it in one place.
- Data users or public budgets carry most costs, so entry stays cheap for small farms.
- Farmer organisations share governance: farmer bodies sit in the JoinData cooperative, and farmer unions run Data-Agri.

BARRIERS

- Funding risk: data intermediaries need stable long-term finance; see AgDataHub under Also worth knowing.
- Voluntary codes lack checks: BO Akkerbouw does not verify signatories in detail; EU Code uptake is unmeasured.
- Low maturity: farmmaps developers estimate under 1% of Dutch farms are mature data-driven farms.
- Platforms depend on providers: agrirouter lost partners' trust when its first version could not keep pace.

3.3 · MORE EXAMPLES

Also worth knowing

Further documented practices in this theme, in brief.

DIGITAL EXPERIMENTAL FIELDS AND DIWENKLA (GERMANY)

The agriculture ministry funded 14 digital experimental fields that started between September 2019 and March 2020, with 60 sub-projects and about €50 million [1]. Five focus on networking and data infrastructure, including DiWenkLa (March 2020 to February 2025), which targets small-structured farms in Baden-Württemberg [1,2]. A survey of the fields analysed 181 technologies [1].

AGRIFOOD CODE OF CONDUCT FOR DATA USE (NETHERLANDS)

BO Akkerbouw renewed its data code in late 2024 and opened it to all of agri-food [3]. Five principles cover control, transparency, interoperability, privacy and portability [3]. Signatories file a self-declaration and enter a public register: 32 organisations in October 2026, including the cooperatives Cosun, Avebe and Agrico and the young farmers' organisation NAJK [4].

AGDATAHUB, A LESSON ON FUNDING (FRANCE)

AgDataHub, a consent and data-exchange platform majority-owned by the farm-sector holding API-Agro, raised €2.5 million from API-Agro and the Banque des Territoires in 2020 [5]. It was placed in judicial liquidation on 3 December 2024 with liabilities of over €1 million; state support agreed in 2024 was never received, according to the company [6].

[1] Gabriel, A., Beneke, F., Gandorfer, M. (2025). Bewertung von digitalen Technologien in den Digitalen Experimentierfeldern. Berichte über Landwirtschaft 103(2). https://www.buel.bmel.de/index.php/buel/article/view/545

[2] Universität Hohenheim (2025). DiWenkLa: Digitale Wertschöpfungsketten für eine nachhaltige kleinstrukturierte Landwirtschaft. Project website. https://diwenkla.uni-hohenheim.de/

[3] BO Akkerbouw (2025). Elf organisaties ondertekenen vernieuwde Gedragscode Datagebruik Agrifood. News, 16 January 2025. https://www.bo-akkerbouw.nl/nieuws/elf-organisaties-ondertekenen-vernieuwde-gedragscode-datagebruik-agrifood

[4] BO Akkerbouw (2026). Gedragscode Datagebruik Agrifood and public register. BO Akkerbouw. https://www.bo-akkerbouw.nl/gedragscode-datagebruik-agrifood

[5] Banque des Territoires (2020). La société Agdatahub lève 2,5M€ de fonds propres auprès d'API-Agro et de la Banque des Territoires. Press release, 4 November 2020. https://www.banquedesterritoires.fr/sites/default/files/2020-11/CP%20Agdatahub%20l%C3%A8ve%202%2C5M%E2%82%AC%20aupr%C3%A8s%20d%E2%80%99API-Agro%20et%20de%20la%20Banque%20des%20Territoires%20-%20souverainet%C3%A9%20num%C3%A9rique%20agricole.pdf

[6] Réussir (2025). Données agricoles : Agdatahub a été placé en liquidation judiciaire. 7 January 2025. https://www.reussir.fr/articles/donnees-agricoles-agdatahub-ete-place-en-liquidation-judiciaire

3.4

Agricultural Robotics

This theme covers field robots and autonomous tractors in four countries: robots that hoe weeds or work vineyard soil, tractors that drive themselves, and research robots that inspect and harvest grapes. It matters because labour for weeding, spraying and harvest is scarce and costly, and robots offer a route to less herbicide use.



Adapazarı (Sakarya): agricultural drone controller during young farmers training, June 2026. AI-assisted illustration based on a real project photograph.

FR	Bakus vineyard robot, contractor model	3.4.1
DE	LWG Bavaria hoeing-robot trials	3.4.1
NL	AgXeed AgBot in Robot zoekt Boer	3.4.2
NL	Ex-demo autonomous tractor in an orchard	3.4.2
GR	BACCHUS grape-harvesting robots	3.4.3
GR	ROBS4CROPS table-grape spraying pilot	3.4.3

FR
FRANCE

3.4.1 · AUTONOMOUS WEEDERS AND HARVESTERS (FRANCE & GERMANY)

Bakus vineyard robot, contractor model

Electric autonomous straddle robot for under-vine soil work, also hired as a service from a contractor.

WHAT IT IS

Bakus is a battery-electric robot that straddles one vine row and does mechanical weeding under the vines and mowing without a driver [1]. The maker presents it as a way to manage vineyard soil without herbicides [1]. In Gironde, the contractor Viti Morley bought a Bakus in February 2022 and sells under-vine soil work to estates as a service, including growers too small to buy a robot [3].

HOW IT WORKS

- Two RTK GPS units position the robot; two inertial units and twelve mechanical detectors slow or stop it [1].
- Before the first job, the contractor maps each row by GPS (€200-400 per ha) plus a €150 VitiBot fee [3].
- Estates pay about €110-130 per hectare under maintenance contracts billed by the hour; the robot works February to July [3].

RESULTS

200+
Bakus robots produced by VitiBot [2]
company figure

€110-130
per hectare charged for contractor soil work [3]
Gironde, 2023

1-14 ha
plot sizes served by one contractor robot [3]
about 50 ha in total

The robot count is reported by the company; prices are as quoted by the contractor in trade press.

No measured savings have been published. The contractor expects payback in three to four years on five-year financing; the client finds the service slightly dearer than conventional work [3].

WHY IT MATTERS FOR TÜRKIYE

For vineyard provinces such as İzmir, a robot that works the soil without herbicides fits the project's aim of lower chemical use. The contractor model matters most: a cooperative or machinery-service provider can own one robot and serve many small plots, so a grower with a few hectares buys a service instead of equipment.

TRANSFERABILITY

Needs reliable RTK correction, a GPS survey of each plot, rows at least 1 m apart [1] and a contractor or cooperative able to keep the robot busy across many plots and to service it.

IMPLEMENTERS

VitiBot, Reims, majority-owned by SDF Group since 2022 [2]; contractor Viti Morley, Gironde [3]

PROGRAMME AND FUNDING

Private company; 40% FranceAgriMer purchase subsidy under France 2030, reported by the company [2]

PERIOD

Company since 2016; contractor service since 2022

SCALE

200+ robots produced [2]; one contractor robot covers about 50 ha on 1-14 ha plots [3]

TECHNOLOGY

Battery-electric straddle robot, two RTK GPS units, inertial units, mechanical safety detectors

TRANSFERABILITY TO TÜRKIYE

Medium

[1] VitiBot (n.d.). Robot viticole Bakus. Product page, VitiBot. https://vitibot.fr/robot-viticole-bakus/

[2] VitiBot (n.d.). VitiBot, qui sommes-nous. Company history page, VitiBot. https://vitibot.fr/lentreprise/vitibot-qui-sommes-nous/

[3] Delbecque, X. (2023). Robot viticole : le recours à l'ETA est adapté aux petites surfaces. Réussir Vigne (trade press), 6 June 2023. https://www.reussir.fr/vigne/robot-viticole-le-recours-leta-est-adapte-aux-petites-surfaces

DE
GERMANY

3.4.1 · AUTONOMOUS WEEDERS AND HARVESTERS (FRANCE & GERMANY)

LWG Bavaria hoeing-robot trials

A state institute tested four commercial hoeing robots in real crops and published costs, limits and prerequisites.

WHAT IT IS

LWG tested the hoeing robots Farming GT, FarmDroid FD20 and Naïo Dino in vegetable crops and Naïo Oz in a tree nursery [1]. Weeds were counted before each weekly pass in fixed frames and compared with the farm's usual hoeing [2]. The institute then calculated labour and machine costs per hectare and published a practical guide for growers [1].

HOW IT WORKS

- Farming GT follows rows with multispectral cameras, neural networks and RTK; FD20 hoes around seed positions it recorded [2].
- Costs combine minimum-wage labour (€17.31 per hour) and machine hours, compared with KTBL standard values for hoeing [1].
- The guide lists prerequisites: flat, stone-free fields, clear headlands, straight rows, exact spacing and mobile coverage [1].

RESULTS

~30%
higher yield per area: Oz allowed 90 cm rows, though weeding cost more [1]
tree nursery trial

2.4-20 ha
weekly capacity, about 2.4 ha (Oz) to at most 20 ha (FD20) [1]
LWG estimate

40%
Bavarian purchase grant, up to €40,000 per field robot [1]
BaySL Digital, until 2027

All robots could match conventional hoeing, but reliable use was not yet possible and hand hoeing was still needed [1]. Under realistic assumptions the robots were only partly cost-competitive [1].

WHY IT MATTERS FOR TÜRKIYE

For vegetable growers in provinces such as Adana, Sakarya or İzmir, the findings are relevant: transport between small plots erodes robot economics, and hand hoeing remains necessary. The method transfers well: a public institute tests robots on farms and publishes costs and limits, so growers can judge before investing, with or without a grant.

TRANSFERABILITY

High for the method: Turkish public institutes could run the same farm trials. Buyers need flat, stone-free plots and service continuity; LWG warns of vendor insolvency, and Naïo entered receivership in June 2025 before an October takeover [1,3,4].

IMPLEMENTERS

Bavarian State Institute for Viticulture and Horticulture (LWG); robots by Farming Revolution, FarmDroid and Naïo [1,2]

PROGRAMME AND FUNDING

Research project of a state institute; 40% BaySL Digital purchase grant until 2027 [1]

PERIOD

December 2021 to February 2025

SCALE

Four robot models; vegetables on a commercial farm and research station, plus a tree nursery [1,2]

TECHNOLOGY

Camera and AI row following, RTK seed mapping with solar power, compact electric robots

TRANSFERABILITY TO TÜRKIYE

High

[1] LWG, Institut für Erwerbs- und Freizeitgartenbau (2025). Mechanische Beikrautregulierung mit Hackrobotern: Informationen für die Praxis in Bayern (Stand Februar 2025). Bayerische Landesanstalt für Weinbau und Gartenbau. https://lwg.bayern.de/mam/cms06/gartenbau/dateien/leitfaden_zu_autonomer_hacktechnik_im_gartenbau__barrierefrei_.pdf

[2] Seehafer, L. (2024). Automatisierte Beikrautregulierung: Hackroboter im Gemüsebau. Versuche im deutschen Gartenbau 2024, LWG. https://lwg.bayern.de/mam/cms06/gartenbau/dateien/versuchsbericht_2024_ief1_seehafer_hackrobotik_gemüsebau.pdf

[3] Réussir (2025). Naïo Technologies placé en redressement judiciaire. Réussir Machinisme (trade press), 13 June 2025. https://www.reussir.fr/machinisme/naio-technologies-place-en-redressement-judiciaire

[4] Réussir (2025). Un repreneur pour les robots Naïo Technologies. Réussir Fruits et Légumes (trade press), 4 November 2025. https://www.reussir.fr/fruits-legumes/un-repreneur-pour-les-robots-naio-technologies

NL NETHERLANDS

3.4.2 · GPS-GUIDED AND AUTONOMOUS TRACTORS (NETHERLANDS)

AgXeed AgBot in Robot zoekt Boer

A national field lab lends an autonomous tracked tractor to a working arable farm for a full season.

WHAT IT IS

The Dutch national field lab for precision farming, NPPL, runs on policy-support research funds of the agriculture ministry LVVN [1]. In February 2025 it began lending field robots to farmers [3]. Arable farmer Marijn Vermuë used an AgXeed AgBot 5.115T2 throughout 2025 on his 160 ha farm, starting with power harrowing for red onions [1,3]. AgXeed, founded in 2018, sold its first AgBot in 2022 [2].

HOW IT WORKS

- NPPL collected several robots and selected farmers from many applicants to test them on their own fields [3].
- At an NPPL+R field day, growers rode a tractor with a GPX iQuus kit; AgXeed demonstrated obstacle stops [4].
- The tracked AgBot may not drive on public roads, so it was moved between parcels by low-loader [1,4].

RESULTS

~485 h

AgBot working hours at the trial farm, covering about 330 ha [1]

21 Feb to end 2025, WUR report

~100,000 h

operating hours on AgXeed counters [4]

reported at NPPL+R field day, 2026

Fleet hours as reported in the field-lab article, most likely from the company; trial hours are from the WUR report.

WUR found the robot slightly slower per operation than a tractor with driver, with minimal differences [1]. In the company's account, its very low footprint allowed early work on a slightly wet field [3].

WHY IT MATTERS FOR TÜRKIYE

For larger arable fields, for example in Ankara or Şanlıurfa, the field-lab model is the transferable part: a ministry-backed programme places a robot on a farm for a year and publishes measured hours and lessons before anyone invests. A light robot that can enter wet soil also matters where compaction is a concern.

TRANSFERABILITY

Suits large, consolidated parcels and contractors or cooperatives that can keep the robot busy. Fragmented holdings add transport effort: the tracked robot may not drive on public roads and must be moved by low-loader [1,4].

IMPLEMENTERS

NPPL field lab with WUR researchers [1]; AgXeed B.V. [2]; farmer Marijn Vermuë, Werkendam [1,3]

PROGRAMME AND FUNDING

LVVN ministry policy-support research (BO-43-226-002) under NPPL [1]

PERIOD

February to end of 2025 (one-year trial)

SCALE

One 160 ha farm, about 485 h and 330 ha worked [1]

TECHNOLOGY

Tracked driverless tractor using standard three-point implements, PTO and ISOBUS [1]

TRANSFERABILITY TO TÜRKIYE

Medium

[1] Van Boheemen, K., Lugtenburg, C. (2026). AgXeed AgBot 5.115T2, Vermuë Akkerbouw: NPPL-rapportage 2025. Wageningen Research, Rapport WPR-OT 1202. https://doi.org/10.18174/710437

[2] AgXeed (n.d.). About AgXeed. Company page. https://www.agxeed.com/about-agxeed/

[3] AgXeed (2025). Robot seeks Farmer! Company news, 30 April 2025. https://www.agxeed.com/robot-seeks-farmer/

[4] Buitenhuis, R. (2026). Robots en autonome trekkers: techniek is er klaar voor. Nu de praktijk nog. NPPL, 13 August 2026. https://www.proeftuinprecisielandbouw.nl/robots-en-autonome-trekkers-techniek-is-er-klaar-voor-nu-de-praktijk-nog/

NL NETHERLANDS

3.4.2 · GPS-GUIDED AND AUTONOMOUS TRACTORS (NETHERLANDS)

Ex-demo autonomous tractor in an orchard

A 25 ha fruit farm runs a kit-equipped tractor driverless, backed by NPPL+R.

WHAT IT IS

Fruit grower Peter Baars bought a Fendt tractor fitted with an iQuus autonomy kit that GPX-Solutions had used as its demonstration tractor; it mows the orchard alleys without a driver [1]. A roof camera counts visible blossom clusters per tree, and the counts become a task map for a sprayer that doses each tree [1]. NPPL+R and a WUR researcher run a precision-thinning trial on the farm [1].

HOW IT WORKS

- The kit-equipped tractor drives itself, but can still be driven manually for other work [1].
- In the thinning trial, trees with more blossom clusters received higher doses, all applied in one pass [1].
- Safety relies on a bumper and LiDAR; the farmer wants detection that recognises obstacles, not only senses them [1].

RESULTS

1 pass

applies all per-tree thinning doses from one task map [1]

pear trial, 2026

25 ha

apple, pear and cherry; 8.5 ha beside the farmyard [1]

other plots within 2 km

The farmer is satisfied with autonomous mowing, but driverless spraying needs tractor and implement to communicate, which almost no implement supports yet [1]. Thinning-trial results are not yet published [1].

WHY IT MATTERS FOR TÜRKIYE

For mid-sized fruit farms in provinces such as İzmir or Sakarya, a tractor fitted with a retrofit kit, new or second-hand, is likely a lower-capital entry to autonomy than a dedicated robot. The same tractor can still be driven conventionally, and plots within a short distance remain workable.

TRANSFERABILITY

In our view it needs satellite positioning, regular tree rows, reliable obstacle detection and, before driverless spraying, implements that communicate with the tractor, which the farmer says most lack [1]. Local dealer support for the kit is also needed.

IMPLEMENTERS

Baarsfruit (Peter Baars), Eck en Wiel; GPX-Solutions (iQuus kit); WUR experts in NPPL+R [1]

PROGRAMME AND FUNDING

Private farm investment; precision-thinning trial under NPPL+R, an LVVN field lab [1,2]

PERIOD

Ex-demonstration tractor with kit bought about 2023; trial 2026

SCALE

One farm: 25 ha of apple, pear and cherry; plots within 2 km [1]

TECHNOLOGY

Fendt tractor with an iQuus autonomy retrofit kit, tree camera, per-nozzle sprayer

TRANSFERABILITY TO TÜRKIYE

Medium

[1] Stallen, J. (2026). Vertrouwen basis voor toepassing nieuwe technologie. NPPL, 10 September 2026. https://www.proeftuinprecisielandbouw.nl/vertrouwen-basis-voor-autonoom-werken/

[2] Wageningen University & Research (n.d.). Nationale Proeftuin Precisielandbouw (BO-43-226-002, BO-43-120.01-004). WUR research project record. https://research.wur.nl/en/projects/nationale-proeftuin-precisielandbouw-bo-43-226-002-bo-43-12001-00/

GR
GREECE

3.4.3 · ROBOTIC UNITS IN EU PILOT PROJECTS (GREECE)

BACCHUS grape-harvesting robots

Two cooperating robots that inspect a vineyard, estimate yield and harvest selected grape bunches with two arms.

WHAT IT IS

BACCHUS developed a robotic system meant to reproduce hand harvesting of grapes [1]. An inspection robot drives the vineyard autonomously, builds a crop map and estimates yield; a harvesting robot then uses the map to pick the highest-quality bunches [2]. The harvester was tested over three seasons, 2021-2023, in the Gerovassiliou vineyard in Thessaloniki [2].

HOW IT WORKS

- The harvester carries two UR10e arms; one moves leaves aside so the camera can find the stem [2].
- Near-infrared spectral libraries estimate grape sugar content without damaging the fruit [2].
- Lidar, RGB-D and hyperspectral data feed localisation, mapping and grape detection modules [2].

RESULTS

3
seasons of field tests at the Gerovassiliou vineyard [2]
2021-2023

35+
open-access publications, including open datasets [2]

€5.1m
EU contribution, covering the full project cost [1]

The project reports fully autonomous inspection and harvesting tests in the vineyard; its CORDIS summary gives no harvesting success rate or labour figure [2].

WHY IT MATTERS FOR TÜRKIYE

Grape harvest is a seasonal labour peak in vineyard provinces such as İzmir. BACCHUS shows a partnership model that Turkish universities and wineries could copy: a university, a research centre and a working winery testing on a real vineyard over several seasons, with open data that others can reuse.

TRANSFERABILITY

Low as a product: the robots are research prototypes, and the project summary gives no performance figures. Higher as a model: Turkish institutes could take part in similar EU research consortia and reuse the project's open datasets [2].

IMPLEMENTERS

Aristotle University of Thessaloniki (coordinator), CERTH, Gerovassiliou winery, with Spanish, Norwegian, British and Italian partners [1]

PROGRAMME AND FUNDING

Horizon 2020 (ICT-10-2019-2020); €5.1 million, fully EU-funded [1]

PERIOD

2020-2023

SCALE

Two robot platforms; three test seasons at one Thessaloniki vineyard [2]

TECHNOLOGY

Inspection robot with hyperspectral camera; dual-arm harvester with lidar and cameras

TRANSFERABILITY TO TÜRKIYE

Low

[1] European Commission, CORDIS (n.d.). BACCHUS: Mobile robotic platforms for active inspection and harvesting in agricultural areas, grant 871704. Project record. https://cordis.europa.eu/project/id/871704

[2] European Commission, CORDIS (n.d.). Periodic Reporting for period 3, BACCHUS (2022-10-01 to 2023-11-30). Project report summary. https://cordis.europa.eu/project/id/871704/reporting

GR
GREECE

3.4.3 · ROBOTIC UNITS IN EU PILOT PROJECTS (GREECE)

ROBS4CROPS table-grape spraying pilot

Greek pilot with a grape cooperative: autonomous spraying by a retrofitted tractor, and robot navigation, in table-grape vineyards.

WHAT IT IS

ROBS4CROPS, coordinated by Wageningen Research, tested robotic crop protection in pilots in Greece, Spain, France and the Netherlands [1,2]. The Greek pilot addressed spraying of table-grape vineyards, where many pesticide and fertiliser passes meet high labour costs and workforce shortages [2]. Partners included the Kiato grape cooperative Pigasos, the Agricultural University of Athens and the University of Patras [1].

HOW IT WORKS

- The 2022 plan: a robot and a retrofitted tractor would share one Teyme sprayer, for comparison [2].
- In 2024 the sprayer exceeded the CAROB robot's capacity, so the tractor sprayed and the robot tested navigation [3].
- Metal supports for overhead nets interfered with GNSS, so the team localised the robots with LiDAR [3].

RESULTS

8
autonomous spraying passes by the retrofitted tractor, April to October [3]
2024 season

4
CAROB robot passes testing autonomous navigation [3]
2024 season

€6.8m
EU contribution to the four-country project [1]

The tractor's length and the narrow headlands prevented autonomous turning [3]. The final report gives no measured savings for the Greek pilot; robotic spraying pays off only with sizeable pesticide savings [3].

WHY IT MATTERS FOR TÜRKIYE

Table-grape vineyards and grape cooperatives exist in both Greece and western Türkiye, for example around İzmir. The lessons are practical: check implement weight against what the robot can carry, and headland space for turning, before automating, and let a cooperative host the pilot so members see results.

TRANSFERABILITY

Retrofitting existing machinery lowers the initial investment [1], and cooperatives can host trials. The hardware is still at pilot stage: implements must match the carrier's capacity, narrow headlands prevented autonomous turning, and navigation must cope with unreliable RTK-GNSS [3].

IMPLEMENTERS

Pigasos grape cooperative (Kiato), Agricultural University of Athens, University of Patras; coordinator Wageningen Research [1]

PROGRAMME AND FUNDING

Horizon 2020 (ICT-46-2020); total €7.9 million, EU contribution €6.8 million [1]

PERIOD

2021-2024

SCALE

One farmer, about 0.46 ha of test and control plots (2023 season) [3]

TECHNOLOGY

AgreenCulture CAROB robot, tractor with autonomy smart box, Teyme sprayer, LiDAR navigation

TRANSFERABILITY TO TÜRKIYE

Medium

[1] European Commission, CORDIS (n.d.). ROBS4CROPS: Robots for protecting crops, grant 101016807. Project record. https://cordis.europa.eu/project/id/101016807

[2] European Commission, CORDIS (2022). Robots help farmers say goodbye to repetitive tasks. CORDIS News, 29 July 2022. https://cordis.europa.eu/article/id/441912-robots-help-farmers-say-goodbye-to-repetitive-tasks

[3] Van Evert, F. (2024). D9.3 Final Report, ROBS4CROPS, 24 December 2024. Wageningen Research for the ROBS4CROPS consortium. https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e516985e11&appId=PPGMS

3.4 · REVIEW

Agricultural Robotics: what the cases show

Across the six cases, robots work in the field but rarely alone: hand hoeing, supervision or a driver for some tasks remain part of the system. Cases most useful to small farms lower the entry cost through contractor services, retrofit autonomy kits on conventional tractors or public field labs that lend robots. Independent measurements of savings are still scarce; many published figures come from manufacturers or from the projects themselves.

CASE	COUNTRY	WHO USES IT	ENTRY COST / EFFORT	EVIDENCE	FIT FOR TÜRKIYE
Bakus via contractor	France	Wine estates, including small ones, through a contractor	€110-130/ha service plus €200-400/ha one-off survey; no purchase	Company figures and trade press	Medium: vineyards, via cooperatives or contractors
LWG hoeing-robot trials	Germany	Vegetable growers and tree nurseries	Robot purchase; 40% Bavarian grant	Independent public field trials and cost study	High as method; robots need flat, stone-free plots
AgXeed in Robot zoekt Boer	Netherlands	Arable farmers; one 160 ha trial farm	Year-long deployment through the field lab	WUR trial report (hours, area), farmer account, field-lab article	Medium: large arable fields; transport needed between parcels
Ex-demo autonomous tractor in an orchard	Netherlands	A 25 ha fruit farm	Second-hand tractor already fitted with a retrofit autonomy kit	Field-lab article; trial results pending	Medium: orchards; implements must communicate with tractor
BACCHUS	Greece	University, research centre and a winery	EU-funded research prototype	Three test seasons; no performance figures in project summary	Low as product; useful research partnership model
ROBS4CROPS Greek pilot	Greece	Grape cooperative and two universities	Retrofitted tractor and robot; EU-funded pilot	CORDIS records and final report	Medium: table grapes, cooperatives; check robot payload

SUCCESS FACTORS

- Service models such as contractor hire or field-lab loans let small growers use robots without buying them.
- Retrofitting conventional tractors can lower capital needs and keeps the tractor usable with a driver for other work.
- Public institutes testing robots on real farms give buyers independent cost and performance data.
- Cooperatives and wineries as project partners keep trials close to everyday farm conditions.

BARRIERS

- Reliability is not yet sufficient: hand hoeing and supervision remained necessary in the Bavarian trials.
- Scattered plots add transport time, tracked robots cannot use public roads, and narrow headlands block autonomous turns.
- Trees and metal net supports disturbed GNSS, requiring LiDAR; the Greek sprayer was too heavy for the robot.
- Young makers can fail: Naïo entered receivership in 2025; the buyer now focuses on two robot models.

3.4 · MORE EXAMPLES

Also worth knowing

Further documented practices in this theme, in brief.

BONIROB FIELD-ROBOT PLATFORM (GERMANY)

BoniRob is a multipurpose field robot by Amazone, Osnabrück University of Applied Sciences and Bosch, funded through BLE by the agriculture ministry (BMELV) [1]. Its modules cover phenotyping, soil measurement, spraying and weeding [2]. Remote-worker weeding in organic carrots was field-tested in 2013 and compared quantitatively with hand weeding, but no figures are given [3].

LELY EXOS AUTONOMOUS GRASS FEEDING (NETHERLANDS)

Lely Exos is an electric vehicle that autonomously mows grass, applies liquid fertiliser and feeds fresh grass in the barn [4,5]. After tests on 13 Dutch farms it was announced for sale from mid-2024 [5]. In 2024, 17 units harvested about 22,000 tonnes of fresh grass, figures reported by the company in trade press [6].

AGROBOFOOD EAST MED CLUSTER (GREECE AND TÜRKIYE)

The EU project agROBOfood (2019 to February 2024) grouped Greece, Türkiye, Cyprus and Israel in an East Med cluster led by the Agricultural University of Athens [7,9]. After a ROBS4CROPS autonomous-spraying demonstration in Kiato, all 46 surveyed farmers and advisers approved the technologies and 96% said their view of the benefits improved [8].

[1] Rahe, F. et al. (2010). Erste Feldversuche mit dem autonomen Feldroboter BoniRob. VDI conference paper, Osnabrück University of Applied Sciences. https://www.hs-osnabrueck.de/fileadmin/HSOS/Homepages/COALA/Veroeffentlichungen/2010-VDI-BoniRob.pdf

[2] Amazone and Osnabrück University of Applied Sciences (n.d.). BoniRob App-concept and RemoteFarming.1. Information sheet MI 4402. https://downloadcenter.amazone.de/file/view/infoid/29417

[3] Sellmann, F. et al. (2014). RemoteFarming.1: Human-machine interaction for a field-robot-based weed control application in organic farming. 4th International Conference on Machine Control & Guidance. https://www.hs-osnabrueck.de/fileadmin/HSOS/Homepages/COALA/Veroeffentlichungen/2014-MCG-RemoteFarming.1.pdf

[4] Lely (2020). Lely is introducing a unique concept for autonomous feeding with fresh grass. Lely news, 6 October 2020. https://www.lely.com/global/news/lely-introducing-unique-concept-autonomous-feeding/

[5] Lely (2023). Lely Exos available from 2024. Lely news, 6 June 2023. https://www.lely.com/global/news/lely-exos-available-from-2024/

[6] profi (2025). Lely Exos zero grazing autonomously: Green meals on autonomous wheels. profi (trade press), 21 December 2025. https://www.profi.co.uk/?p=30121

[7] agROBOfood (n.d.). East Med regional cluster. agROBOfood project website. https://agrobofood.eu/regional-clusters/east-med

[8] Papantonatou, M.-Z., Papadopoulos, G., Uyar, H., Van Evert, F., Fountas, S. (2024). Shaping the agricultural future: Engaging stakeholder feedback for the development of agricultural robotic solutions. AgEng2024, Zenodo. https://doi.org/10.5281/zenodo.13919526

[9] European Commission, CORDIS (n.d.). agROBOfood: Business-Oriented Support to the European Robotics and Agri-food Sector, grant 825395. Project record. https://cordis.europa.eu/project/id/825395

3.5

AR/VR and Simulation in Drone Training

This theme covers simulators, VR, AR and online courses used to train drone pilots, machinery operators and farm staff in Germany, France, the Netherlands and Greece. It matters because these skills are scarce, mistakes are costly, and EU rules require drone pilots to complete training and pass exams before most farm drone operations.



Polatlı (Ankara): training of trainers participants on a field visit, May 2026. AI-assisted illustration based on a real project photograph.

FR	Vinum: E-CAB and Ampélos	3.5.1
DE	SilA: VR stations in farm VET	3.5.1
NL	Augmented Horticulture	3.5.2
NL	GoDrone airspace app	3.5.2
GR	AgroPro drone MOOC	3.5.3
GR	Drones4GREEN simulation training	3.5.3

FR
FRANCE

3.5.1 · VR AND SIMULATOR TRAINING (GERMANY, FRANCE)

Vinum: E-CAB and Ampélos

Publicly funded programme bringing a machinery driving simulator and a VR vine-pruning trainer into French agricultural schools.

WHAT IT IS

Vinum is a France 2030 programme, led by the UNIT foundation, that develops immersive training tools for agricultural, wine and forestry courses [1]. E-CAB is a driving simulator for agricultural machinery that lets trainees change weather and light and test machine limits such as weight, inertia and blind spots [1]. Ampélos trains vine pruning in a VR headset with virtual secateurs, and an avatar helps trainees adopt correct postures [2].

HOW IT WORKS

- A public call funds a consortium of schools, universities, a research institute and firms to build shared tools [1].
- E-CAB adds scenarios for vineyard, arable, implement and sprayer work and is deployed in schools [1].
- Trainees practise operations that cannot be done in class, and work safely before going to the field [1].

RESULTS

>6,000

people have tried the E-CAB simulator [1]

fairs, safety events, dealers; to 2023

8

French regions covered by the Vinum network [1]

Ampélos won the gold innovation medal at the SITEVI trade fair [2]. The programme planned to sell E-CAB and Ampélos commercially from 2024 [2]. No learner-outcome figures have been published.

WHY IT MATTERS FOR TÜRKIYE

Agricultural vocational schools in Türkiye are likely to face similar constraints: machinery is costly and risky, and practice time is short. One simulator platform, built by a consortium and shared by many schools, could add tractor, sprayer and later drone-spraying scenarios for trainees in pilot provinces such as Adana and Şanlıurfa.

TRANSFERABILITY

The model, a public call co-funding a consortium of schools, research and industry, transfers well. The programme planned to commercialise the tools from 2024 [2], so Turkish use would likely need licences, Turkish-language content and local machine models.

IMPLEMENTERS

UNIT foundation (lead) with CEA-List, Maison Hennessy, Studio Nyx, two universities and public agricultural schools (EPLEFPA).

PROGRAMME AND FUNDING

France 2030, call 'Compétences et Métiers d'Avenir' (Banque des Territoires); laureate May 2022.

PERIOD

June 2022 to June 2025

SCALE

Ecosystem covering 8 French regions; over 6,000 people have tried E-CAB [1]

TECHNOLOGY

3D machinery driving simulator; VR headset with virtual secateurs and avatar.

TRANSFERABILITY TO TÜRKIYE

Medium

[1] Fondation UNIT (2023). Dossier de presse Vinum. Fondation UNIT. https://unit.eu/wp-content/uploads/2023/05/dossier-de-presse-vinum.pdf
[2] Fondation UNIT (2024). Rapport d'activités 2023. Fondation UNIT. https://unit.eu/wp-content/uploads/2024/03/rapport-d-activites-2023.pdf

DE
GERMANY

3.5.1 · VR AND SIMULATOR TRAINING (GERMANY, FRANCE)

SilA: VR stations in farm VET

VR headsets, a touch table and sensor-equipped animal models in inter-company training for apprentice farmers.

WHAT IT IS

SilA brought simulation and virtual reality into the inter-company training that apprentice farmers attend at Haus Düsse [1]. It targets animal-welfare-sensitive tasks that cannot be practised on live animals during courses, such as dehorning calves and the emergency killing of pigs [2]. A sensor-equipped tool on a model gives immediate feedback through an app, so trainees build routines before working on live animals [3].

HOW IT WORKS

- Trainees rotate through three stations: multitouch table, VR headsets and the demonstrator [3].
- VR quizzes guide trainees step by step, adding explanations and short videos after wrong answers [3].
- Instructors and vets helped develop the tools [3]; involving instructors from the start proved key to acceptance [1].

RESULTS

2023/24
school year the stations became part of regular courses [3]

3
partner training and research centres in other Länder [2]

BIBB reports that VR and other digital methods made the training more attractive [1]. No trainee numbers or learning-outcome figures have been published.

WHY IT MATTERS FOR TÜRKIYE

Agricultural vocational schools and farmer training centres in Türkiye could use the same station model for tasks that are risky or rare in practice, such as pesticide spraying or drone pre-flight checks. The main effort is not the hardware but involving instructors early, as the SilA team found.

TRANSFERABILITY

Transfers well wherever a central practical training centre exists. It needs a modest budget for the demonstrator and digital content, instructor time, and adaptation of the content to Turkish curricula.

IMPLEMENTERS

Haus Düsse research and training centre of the North Rhine-Westphalia Chamber of Agriculture.

PROGRAMME AND FUNDING

BMBF special programme ÜBS-Digitalisierung for inter-company training centres (2016–2023) [4].

PERIOD

04/2021 to 06/2023

SCALE

In regular inter-company courses since school year 2023/24; three partner centres [2,3]

TECHNOLOGY

VR headsets, multitouch table, model calf with sensor tool and feedback app.

TRANSFERABILITY TO TÜRKIYE

High

[1] BIBB (2024). SilA: Simulationsgestütztes und immersives Lernen in der landwirtschaftlichen Ausbildung. Bundesinstitut für Berufsbildung. https://www.bibb.de/de/sila-137269.php
[2] BIBB (n.d.). Drei Fragen an SilA. Bundesinstitut für Berufsbildung, Sonderprogramm ÜBS-Digitalisierung. https://www.bibb.de/de/151585.php
[3] BIBB (n.d.). SilA: Drei Fragen zum Projektabschluss an Imke Albers. Bundesinstitut für Berufsbildung. https://www.bibb.de/de/199860.php
[4] BIBB (n.d.). Sonderprogramm ÜBS-Digitalisierung. Bundesinstitut für Berufsbildung. https://www.bibb.de/de/36926.php

NL NETHERLANDS

3.5.2 · AUGMENTED REALITY AND DIGITAL OVERLAYS (NETHERLANDS)

Augmented Horticulture

AR glasses that guide greenhouse scouting and help train new harvest staff, tested by WUR with industry partners.

WHAT IT IS

Augmented Horticulture was a four-year project run by Wageningen Research with seed, software and telecom companies [1]. It tested whether AR glasses can give greenhouse workers digital information about the plant they are looking at [2]. The first showcase aimed to have the glasses count the stamens of gerbera flowers, so that new harvest staff learn to recognise flowers ready for picking [2].

HOW IT WORKS

- A second showcase turns infrared sensor readings into colour overlays that show plant stress [2].
- Other showcases locate the wearer and gaze direction, and turn spoken notes into text for scouts [2].
- Plant data come from a cloud database, first via QR codes [1,2], later via the glasses' 3D map [3].

RESULTS

4

AR showcases planned with industry partners [2]

2019–2023

9

beneficial technologies to combine with AR in livestock and crops (WUR review) [4]

No outcome figures have been published. The project sheet lists open questions such as the learning curve and payback [1]; WUR later found the greenhouse blocks wifi and used the glasses' 3D map instead [3].

WHY IT MATTERS FOR TÜRKIYE

Where greenhouse growers in Türkiye rely on seasonal or new staff, AR guides for harvest readiness or pest scouting could shorten onboarding. A pilot with a grower cooperative in İzmir or Adana could start on phones or tablets rather than headsets, keeping costs and connectivity demands low.

TRANSFERABILITY

Medium: still at pilot stage. Transfer needs a research partner and plant data to overlay. WUR worked around greenhouse wifi blocking with the glasses' own 3D map [3], and asked whether tablets beat glasses [1].

IMPLEMENTERS

Wageningen Plant Research with Syngenta Seeds, Florensis, LetsGrow, Mprise, KPN and Itelligence.

PROGRAMME AND FUNDING

Dutch Top Sector Horticulture & Starting Materials (TU18145), co-funded by the consortium.

PERIOD

2019–2023

SCALE

Four showcases planned on HoloLens 2; no user numbers published [2]

TECHNOLOGY

Microsoft HoloLens 2, QR and position tracking, infrared stress sensing, speech-to-text.

TRANSFERABILITY TO TÜRKIYE

Medium

[1] Balendonck, J., Ruizendaal, J., Peller, J., Petropoulou, A., Vroegop, A., van Daalen, T., van de Zedde, R. (n.d.). Augmented Horticulture: Het gewas leren kennen via Augmented Reality. Wageningen Plant Research. https://edepot.wur.nl/542263

[2] Wageningen University & Research (2020). AR-bril vertelt of gerbera geoogst kan worden. WUR news, 7 July 2020 (archived copy). https://edepot.wur.nl/542802

[3] Wageningen University & Research (2021). AR glasses also work in a greenhouse without WiFi. WUR news, 4 January 2021 (archived copy). http://web.archive.org/web/20230616171421/https://www.wur.nl/en/newsarticle/ar-glasses-also-work-in-a-greenhouse-without-wifi.htm

[4] Hurst, W., Mendoza, F.R., Tekinerdogan, B. (2021). Augmented Reality in Precision Farming: Concepts and Applications. Smart Cities 4(4), 1454–1468. https://doi.org/10.3390/smartcities4040077

NL NETHERLANDS

3.5.2 · AUGMENTED REALITY AND DIGITAL OVERLAYS (NETHERLANDS)

GoDrone airspace app

Official Dutch map and app showing drone pilots airspace limits, hazards and weather, with digital flight approvals.

WHAT IT IS

GoDrone is a suite of applications that gives recreational and commercial drone pilots in the Netherlands flight-management tools and safety information [1]. Notices to airmen, ground hazards, terrain and current weather are shown on an interactive map and in area reports [1]. A registration-free safety map helps operators identify flight risks in the air and on the ground [1].

HOW IT WORKS

- Pilots create an account, add their drones and submit mission plans in the portal or mobile app [1,2].
- GoDrone checks whether approval is needed and, if so, sends a digital request to LVNL [2].
- The Dutch Air Force handles military control zones; air traffic control clearance is still needed [2].

RESULTS

No user or approval figures have been published.

WHY IT MATTERS FOR TÜRKIYE

Farm drone trainees in Türkiye also need to check airspace before every flight. GoDrone shows how an official map with digital approval turns a legal requirement into a routine step. A Turkish curriculum can include a pre-flight check exercise using Türkiye's official drone registration and airspace tools (SHGM; check current systems).

TRANSFERABILITY

The tool depends on the national aviation authority and air navigation service, not on farm actors. What transfers directly is the training practice: build an airspace check into every practical drone lesson.

IMPLEMENTERS

Platform 'Powered by GuardianUTM', copyright INDRA [1]; LVNL Operational Helpdesk handles approvals for civil control zones [2].

PROGRAMME AND FUNDING

Funding not published.

PERIOD

In operation (FAQ dated 1 September 2026)

SCALE

Approvals for civil control zones Schiphol, Lelystad, Rotterdam, Maastricht and Eelde [2]

TECHNOLOGY

Web and mobile interactive map; online mission planning and approval.

TRANSFERABILITY TO TÜRKIYE

Medium

[1] GoDrone (2026). Welcome to GoDrone. GoDrone platform for drone pilots in the Netherlands. https://www.godrone.nl/
[2] GoDrone (2026). GoDrone: Frequently Asked Questions, version 01 Sep 2026. GoDrone. https://www.godrone.nl/faq

GR
GREECE

3.5.3 · REMOTE AND BLENDED DRONE-PILOT TRAINING (GREECE)

AgroPro drone MOOC

Free Erasmus+ online course teaching farmers, cooperatives and advisers how to use drones and follow EU drone rules.

WHAT IT IS

AgroPro was an Erasmus+ vocational project coordinated by the Agricultural University of Athens [1]. It set out to familiarise agricultural professionals with drone technologies and software, international UAV rules, mission planning, and open-source and commercial tools [2]. Its main target groups are small and medium farmers, agricultural cooperatives, agricultural consultants and agri-food employees [3]. The resulting MOOC offers free training in drone use for agriculture [2].

HOW IT WORKS

- Four modules: farm challenges, drones and sensors, flight risk and preparedness, and European drone regulation [3].
- Each module ends with a short multiple-choice or true-false self-assessment quiz [3].
- Content adapts to two levels, based on trainees' background, digital literacy and existing skills [3].

RESULTS

4
online modules on drone use, flight risk and regulation [3]

€250,000
project budget reported by the coordinator [4]
Erasmus+ KA220-VET

A mini conference to present the MOOC was announced for 20 November 2024 at the university [2]. No enrolment or completion figures have been published.

WHY IT MATTERS FOR TÜRKIYE

Free, self-paced theory suits farmers and cooperative staff in all five pilot provinces, for whom long residential courses are hard to attend. A Turkish version of the AgroPro modules, with the regulation module rewritten for Türkiye's rules, could become the online first step before practical flight training.

TRANSFERABILITY

High: the format needs only an e-learning platform and translated content. The regulation module must be rebuilt for Türkiye, and supervised practical flights must be organised separately with a certified trainer.

IMPLEMENTERS

Agricultural University of Athens (coordinator) with Innovation Hive (GR), Iscte (PT), Future Needs (CY) and DO-JOA (PT).

PROGRAMME AND FUNDING

Erasmus+ KA220-VET cooperation partnership; budget EUR 250,000 [4].

PERIOD

December 2022 to December 2024

SCALE

Four online modules with self-assessment quizzes; enrolment figures not published [3]

TECHNOLOGY

MOOC on an e-learning platform, quizzes, competence framework, career e-guide.

TRANSFERABILITY TO TÜRKIYE

High

[1] AgroPro consortium (2023). Partners. AgroPro Drone project website (Erasmus+ 2022-1-EL01-KA220-VET-000088550). https://agropro-drone.eu/?page_id=98

[2] Agricultural University of Athens (2024). The Agricultural University of Athens organizes a Mini Conference on Drone Training for Sustainable Agriculture. Press release, 18 November 2024. https://www2.aua.gr/en/node/2964

[3] Psiroukis, V. (correspondence), Agricultural University of Athens (2024). AgroPro Course Curriculum, Final Version 1.3. AgroPro project. https://agropro-drone.eu/wp-content/uploads/2024/12/AgroPro-Curriculum.pdf

[4] Agricultural University of Athens, Department of Agribusiness (n.d.). Erasmus+ Agricultural Drone Technology Awareness Training for industry Professionals (AGROPRO). Project page. https://w1.aua.gr/agribusiness/en/research_afp/erasmus-agricultural-drone-technology-awareness-training-for-industry-professionals-agropro-2/

GR
GREECE

3.5.3 · REMOTE AND BLENDED DRONE-PILOT TRAINING (GREECE)

Drones4GREEN simulation training

Erasmus+ training in Kozani combining a drone-control simulation lab with mission planning and supervised field flights.

WHAT IT IS

Drones4GREEN is an Erasmus+ higher-education project that develops drone curricula, mobile flight-support apps and a digital hub, with a work package on drones for agriculture [1]. In December 2025 it ran a three-day training at the University of Western Macedonia campus in Kozani [2]. Sessions moved from drone technology and mission planning to a drone-control simulation lab and then to on-field flights [2].

HOW IT WORKS

- Day 1: drone technology, then a mission-planning lab run by Democritus University of Thrace [2].
- Day 2: air-pollution monitoring with drones, then a drone-control simulation lab run by GEOSENSE [2].
- Day 3: practical training and on-field flights; GEOSENSE is a licensed UAS training centre [2,4].

RESULTS

90.5%
of respondents very satisfied with the simulation lab [3]
21 consortium respondents, incl. organisers

85.7%
very satisfied with practical training and field flights [3]
21 consortium respondents, incl. organisers

The results come from the project's own survey of 21 attendees, all from consortium organisations (TU Sofia, DUTH, GEOSENSE, K3Y, Metamind), including the organisers; no data on skills gained have been published [3].

WHY IT MATTERS FOR TÜRKIYE

The training took place in Kozani, home of VERDE, a partner in this report's project (not in Drones4GREEN), so a joint Turkish-Greek drone training day is realistic. Its order (theory, mission planning, simulator, supervised flights) lets beginners such as young farmers make their first mistakes on screen rather than with a real drone.

TRANSFERABILITY

Authors' estimate: a simulator lab needs PCs, controllers, simulator software and one or two training drones. A licensed UAS training centre, as here, brings certified instructors; official certificates still require civil aviation authority exams.

IMPLEMENTERS

Technical University of Sofia (BG, coordinator); DUTH, Metamind Innovations and GEOSENSE (GR); partners in BG and SE.

PROGRAMME AND FUNDING

Erasmus+ KA220-HED cooperation partnership; total value EUR 400,000 [4].

PERIOD

Training session 9–11 December 2025

SCALE

21 evaluation responses, all from consortium organisations [3]

TECHNOLOGY

Drone-control simulation lab, mission-planning lab, on-field drone flights.

TRANSFERABILITY TO TÜRKIYE

High

[1] Drones4GREEN (2026). Drones4GREEN project website (Erasmus+ 2022-1-BG01-KA220-HED-000090004). https://drones4green.eu/

[2] Drones4GREEN (2025). Drones4GREEN Training Session, 9–11 December 2025: agenda. Metamind Innovations for the Drones4GREEN consortium. https://drones4green.eu/wp-content/uploads/2025/12/Drones4GREEN_Training-Agenda.pdf

[3] Drones4GREEN (2026). Evaluation of the Drones4GREEN Training Session 9–11.12.2025. Participant survey summary. https://drones4green.eu/wp-content/uploads/2026/01/Evaluation-of-the-Drones4GREEN-Training-Session-9-11.12.2025.pdf

[4] Drones4GREEN (2026). Partners. Drones4GREEN project website. https://drones4green.eu/partners/

3.5 · REGULATORY FRAME

The rules that shape drone training

EU drone rules decide what a farm drone pilot must learn and prove, and EU pesticide rules decide whether a drone may spray at all. All four countries follow the same EASA training structure, national bodies run the exams, and drone spraying is allowed only under narrow national exceptions.

THREE CATEGORIES, ONLINE BASIC TEST

Regulation (EU) 2019/947 (applied from 31 December 2020) sets open, specific and certified categories [1]. A1/A3 training is an online course and 40-question online exam (pass mark 75%) [1]. Proofs and certificates last five years; minimum age is 16, which Member States may lower [1].

A2 CERTIFICATE AND SPECIFIC CATEGORY

The A2 certificate adds declared practical self-training and a further exam of at least 30 questions [1]. Open-category drones may not drop material, so spraying needs at least the specific category, normally an operational authorisation from the aviation authority (standard scenarios exclude dangerous goods) [1,2].

NATIONAL BODIES RUN THE EXAMS

Germany's LBA offers a free online A1/A3 course, with a EUR 25 exam and certificate fee [3]. France's DSAC platform offers free A1/A3 training and exam [4]. In the Netherlands the RDW issues certificates [5]. Greek providers prepare candidates for Civil Aviation Authority certificates [6].

AERIAL SPRAYING BANNED, WITH EXCEPTIONS

Directive 2009/128/EC bans aerial spraying; derogations require no viable alternative or clear advantages, approved products, a certified operator and an approved plan [7]. A Commission proposal of December 2025 would let Member States exempt identified drone types; Council talks were ongoing in September 2026 [8,9].

GERMANY: STEEP VINEYARDS ONLY

Germany allows drone application of pesticides only in steep vineyards (at least 30% slope) and forest canopies, with BVL-approved products and JKI-listed sprayers [9,10,11]. By the end of 2025, 464,001 A1/A3 and 29,113 A2 exams had been passed there [12].

FRANCE: SLOPES OF 20% OR MORE

A French law of 23 April 2025, put into effect by implementing orders of May 2026, lets authorities authorise drone application of biocontrol, organic-approved and low-risk products on plots with slopes of 20% or more, in banana plantations and in ground-trained rootstock vineyards [13,14].

WHAT THIS MEANS FOR A DRONE CURRICULUM IN TÜRKIYE

- Start with online theory that mirrors EASA A1/A3, then a simulator stage, then supervised flights.
- Treat spraying as an advanced module combining pilot certification and pesticide-applicator training, as EU rules do.
- Teach airspace checks and risk assessment every lesson; spraying, spreading, heavy or beyond-line-of-sight flights are not open category.
- Align licence content with Türkiye's own drone rules, set by the civil aviation authority SHGM; check current requirements.

[1] European Commission (2019, consolidated 2025). Commission Implementing Regulation (EU) 2019/947 on the rules and procedures for the operation of unmanned aircraft, consolidated text of 01.05.2025. Publications Office of the EU. http://publications.europa.eu/resource/cellar/709b3112-2aa3-11f0-8a44-01aa75ed71a1.0006.02/DOC_1
[2] EASA (n.d.). Specific category: civil drones. European Union Aviation Safety Agency. https://www.easa.europa.eu/en/domains/drones-air-mobility/operating-drone/specific-category-civil-drones
[3] Luftfahrt-Bundesamt (n.d.). Anforderungen an Fernpiloten. LBA. https://www.lba.de/DE/Drohnen/Fernpiloten/Anforderungen_Fernpiloten_node.html
[4] Ministère de la Transition écologique (2026). Formation catégorie ouverte UAS. ecologie.gouv.fr. https://www.ecologie.gouv.fr/politiques-publiques/formation-categorie-ouverte-uas
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[6] Agricultural University of Athens, KEDIVIM (2026). Τηλεπισκόπηση & Πιστοποίηση Χειριστή Συστημάτων μη Επανδρωμένων Αεροσκαφών, Β, Γ και Δ κύκλος. Study guide. https://w1.aua.gr/kedivim/wp-content/uploads/sites/12/2026/08/Ενημερωτικός-Οδηγός-Σπουδών-ΕΠ-ΚΕΔΙΒΙΜ-ΤΗΛΕΠΙΣΚΟΠΗΣΗ-Κ-ΠΙΣΤΟΠΟΙΗΣΗ-Β-Γ-ΚΑΙ-Δ-ΚΥΚΛΟΣ.pdf
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[8] European Commission (2025). COM(2025) 1021 final: proposal amending Directive 2009/128/EC and other acts (food and feed safety simplification). European Commission. https://food.ec.europa.eu/document/download/f08402e6-de66-4082-bf8d-ec3aff7787bb_en?filename=horiz_omnibus_dir_com-2025-1021-1part1.pdf
[9] Deutscher Bundestag (2026). Drucksache 21/8258: Antwort der Bundesregierung (agricultural drones), 28 September 2026. https://dserver.bundestag.de/btd/21/082/2108258.pdf
[10] Federal Republic of Germany (2012). Pflanzenschutzgesetz (PflSchG), § 18 Anwendung mit Luftfahrzeugen. gesetze-im-internet.de. https://www.gesetze-im-internet.de/pflschg_2012/__18.html
[11] Deutscher Bundestag (2019). Drucksache 19/12901: Antwort der Bundesregierung, 2 September 2019. https://dserver.bundestag.de/btd/19/129/1912901.pdf
[12] Luftfahrt-Bundesamt (2026). Statistiken Unbemannte Luftfahrtsysteme: Prüfungen Fernpiloten (cumulative totals by year). LBA. https://www.lba.de/SharedDocs/Downloads/DE/SBl/SBl3/Statistiken/Betrieb/UAS_PruefungenFernpiloten.xlsx?__blob=publicationFile&v=3
[13] Sénat (2025). Texte adopté n° 103 (2024-2025): proposition de loi visant à améliorer le traitement des maladies affectant les cultures végétales à l'aide d'aéronefs télépilotés (became Loi n° 2025-365 of 23 April 2025). https://www.senat.fr/leg/tas24-103.html
[14] Ministère de l'Agriculture, de l'Agro-alimentaire et de la Souveraineté alimentaire (2026). Protection des cultures : publication des textes autorisant l'utilisation de drones pour l'application de certains produits phytopharmaceutiques. Press release, 10 June 2026. https://agriculture.gouv.fr/protection-des-cultures-publication-des-textes-autorisant-lutilisation-de-drones-pour-lapplication

3.5 · REVIEW

AR/VR and Simulation in Drone Training: what the cases show

Simulation and VR are most mature in vocational training for machinery and farm tasks (France, Germany), while AR in farming is still at pilot stage (Netherlands). Drone training itself is mostly online theory plus supervised flights, with simulator labs as a bridge (Greece). None of the cases publishes learning-outcome data, so their value rests on design, reach and fit with certification rules.

CASE	COUNTRY	WHO USES IT	ENTRY COST / EFFORT	EVIDENCE	FIT FOR TÜRKIYE
Vinum: E-CAB and Ampélos	FR	Agricultural schools and training centres in 8 regions	Consortium development; commercialisation planned from 2024	Over 6,000 people tried E-CAB; SITEVI gold medal	Machinery and sprayer safety in vocational schools
SilA	DE	Apprentice farmers at an inter-company training centre	Two-year development project (2021–2023)	In regular courses since 2023/24; no outcome figures	Station model for risky or rare tasks
Augmented Horticulture	NL	Greenhouse growers, breeders and new harvest staff	HoloLens 2, research partner, greenhouse connectivity	Four pilot showcases; no outcome figures	Greenhouse onboarding pilots, phones or tablets first
GoDrone	NL	Recreational and commercial drone pilots	Registration-free map; account needed for approvals	Official service; no usage figures	Airspace-check exercise in drone curricula
AgroPro	GR	Small farmers, cooperatives, agricultural consultants	Free MOOC; translation and regulation rewrite needed	MOOC presentation announced for November 2024; no enrolment figures	Online first step for farmers and cooperatives
Drones4GREEN	GR	Higher-education students and staff of partner organisations	Simulation lab, training drones and a licensed instructor (authors' estimate)	21 survey responses from partner staff; 90.5% very satisfied with simulator	Joint Turkish-Greek training days with VERDE

SUCCESS FACTORS

- Consortia of schools, universities, firms and licensed trainers share development cost and bring in certified instructors.
- Simulators let trainees repeat risky tasks safely before using real machines, animals or drones.
- Free online theory plus short supervised practice aims at dispersed rural learners; reach is unmeasured.
- Involving instructors from the start improves acceptance of new training tools.

BARRIERS

- No case publishes learning-outcome data, so effectiveness is not yet proven.
- Greenhouses blocked wifi and headset practicality remained an open question; tablets may be a simpler start.
- Drone spraying needs a national derogation and a pesticide certificate on top of a pilot licence.
- Publicly funded tools may be commercialised (Vinum planned this from 2024), so later users may need licences.

3.5 · MORE EXAMPLES

Also worth knowing

Further documented practices in this theme, in brief.

SPRAY DRONES FOR STEEP VINEYARDS (GERMANY)

An EIP-AGRI Operational Group in Baden-Württemberg (2017–2020, EUR 446,129) brought a drone firm, the LVWO Weinsberg institute, two wine cooperatives and two wine estates together to introduce a spray drone flying pre-planned routes in steep, hand-worked vineyards [1]. The project also instructed inexperienced people to carry out drone spraying [1]. No outcome figures were published.

UNIVERSITY DRONE-LICENCE COURSES (GREECE)

The Agricultural University of Athens runs 50-hour drone-operator courses for A1/A3 and A2 licences: 17 hours live online, 24 hours self-paced and 9 hours in person [2], with Civil Aviation Authority exams [3]. A separate 75-hour course adds practical flight training with a spraying drone for crop protection [4].

[1] EU CAP Network (n.d.). Implementation of spry drones in steep slope viticulture. EIP-AGRI Operational Group project page. European Commission. https://eu-cap-network.ec.europa.eu/projects/implementation-spry-drones-steep-slope-viticulture_en

[2] Agricultural University of Athens, KEDIVIM (2024). Βασική εκπαίδευση χειριστών ΣμηΕΑ: Απόκτηση διπλώματος A1/A2/A3. Study guide. https://w1.aua.gr/kedivim/wp-content/uploads/sites/12/2025/04/ΤΕΛΙΚΟ_Ενημερωτικός-Οδηγός-Σπουδών-Βασική-εκπαίδευση-χειριστών-ΣμηΕΑ-2023-2024.pdf

[3] Agricultural University of Athens, GIS Research Unit (2025). Drone Operator Training, 4th Cycle. News page. https://gis.aua.gr/en/4ος-κύκλος-εκπαίδευσης-χειριστών-drone/

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Feke (Adana): local policy dialogue meeting with women farmers, February 2026. AI-assisted illustration based on a real project photograph.

4 Key lessons and recommendations

4.1 Success factors

A SERVICE AROUND ONE DECISION

Nitrogen advice from satellite images, irrigation steering from tensiometers or soil probes and variable-rate task maps succeed because they answer one question the farmer already asks: how much, where, when.

NEUTRAL INFRASTRUCTURE AND CLEAR DATA RULES

State-run portals, national field labs, cooperative-owned consent platforms and sector data codes build the trust that private platforms alone did not create.

LEARNING IN REAL FARMS

Field labs, operational groups and independent evaluations test technology on working farms and publish what did not work, which farmers value as much as what did.

4.2 Challenges

COST AND SCALE

Robots, greenhouse systems and sensors still need significant investment; small parcels make many machines uneconomic without shared use or a contractor.

FRAGILE BUSINESS MODELS

Young technology firms can fail: the French data platform AgDataHub was liquidated in 2024, and the robot maker Naïo entered receivership in 2025 before being taken over.[2,3] Public evaluations warn farmers about dependence on a single supplier.

SKILLS, CONNECTIVITY AND RULES

Digital skills, reliable positioning signals and mobile coverage remain uneven; drone spraying and autonomous machines are tightly regulated.

EVIDENCE FROM EUROPEAN FARMERS

In a JRC survey of 971 farmers in five European countries (Belgium, Germany, Greece, the Netherlands and the United Kingdom), peer-to-peer learning was the most important factor that influenced adoption of variable-rate nitrogen and machine guidance. Direct technical assistance, training and support might encourage adoption by 58–70% of the surveyed farmers.[1]

[1] Soto, I. et al. (2019). The contribution of Precision Agriculture Technologies to farm productivity and the mitigation of greenhouse gas emissions in the EU. JRC, EUR 29320 EN, pp. 5, 11 and 22. doi:10.2760/016263

[2] Réussir (2025). Données agricoles : Agdatahub a été placé en liquidation judiciaire, 7 January 2025 (liquidation ordered on 3 December 2024). https://www.reussir.fr/articles/donnees-agricoles-agdatahub-ete-place-en-liquidation-judiciaire

[3] Réussir (2025). Un repreneur pour les robots Naïo Technologies, 4 November 2025; and Naïo Technologies placée en redressement judiciaire, 13 June 2025. https://www.reussir.fr/fruits-legumes/un-repreneur-pour-les-robots-naio-technologies

4.3 Strategic recommendations

1. **Prioritise modular, decision-based services.** Begin with one measurement and one decision (soil moisture for irrigation, satellite maps for nitrogen) and add layers as farmers see results.
2. **Embed digital agriculture in vocational and extension training.** Use simulators, VR stations and blended online courses for young farmers and advisers, as agricultural training centres in Germany, France and Greece already do.
3. **Build public-private-academic partnerships around neutral infrastructure.** National field labs and state data portals let research, advisers, cooperatives and companies work on shared ground.
4. **Agree data rules before platforms.** Farmer consent, transparent contracts and a sector code (as in the EU Code of Conduct, the Dutch data code and the French Data-Agri label) should come first.
5. **Lower entry costs through sharing.** Cooperatives, contractor services and autonomy kits for standard tractors make robots and drones accessible to small farms.
6. **Evaluate independently and publish.** Pilots should measure results with a comparison and publish limitations, as the independent Bavarian robot evaluation did.
7. **Localise, do not copy.** Calibrate models and thresholds to local crops, soils and climate, and deliver tools in Turkish through trusted local actors.

4.4 Alignment with EU policy

These recommendations are consistent with the EU's **Farm to Fork Strategy** (2020), which aims to reduce the use of fertilisers and pesticides; the **Common Agricultural Policy 2023–2027**, whose strategic plans must set out how advice, knowledge exchange and digital technologies are supported in Agricultural Knowledge and Innovation Systems (AKIS) under Regulation (EU) 2021/2115; the **Horizon Europe** research and innovation programme; the EU's drone rules (Implementing Regulation (EU) 2019/947); and the EU Code of Conduct on agricultural data sharing by contractual agreement, a voluntary code agreed in 2018 by EU-level farming and agri-business associations. For Türkiye, they also connect with **IPARD III**, the rural development programme of the EU and Türkiye.



Polatlı (Ankara): field training on soil sensors and irrigation in a walnut orchard, May 2026. AI-assisted illustration based on a real project photograph.

5
Transferability and local adaptation in Türkiye

5.1 Enabling conditions in Türkiye

77%
of water used in Türkiye goes to irrigation (2021)[1]

52%
irrigation efficiency in DSİ schemes (2025)[2]

up to 40%
water saved in DSİ sensor-based irrigation pilots (Adana, Afyonkarahisar, Denizli)[3]

70%
grant for sensor-based smart irrigation and automation (Communiqué 2026/10)[4]

5%
of chamber of agriculture members aged 18–32 (2024)[5]

19% → 86%
internet use among skilled agricultural workers, 2013 to 2026[6]

The direction is clear: water is the binding constraint, public support for sensor-based irrigation is in place, and digital access among farm workers has risen fast. The gaps are in advice, skills and the age structure of farming: 8 in 10 people working in agriculture have at most lower secondary education.[7]

[1] Ministry of Agriculture and Forestry of Türkiye (2023). Water Efficiency Strategy and Action Plan 2023–2033, pp. 20 and 43 (DSİ, 2021 data).
[2] State Hydraulic Works (DSİ) (2026). 2025 Annual Report, p. 109.
[3] DSİ (2025). Yapay Zeka Destekli Sulama Otomasyonu ile Su Tasarrufu, news release, 7 April 2025. https://dsi.gov.tr/Haber/Detay/15112
[4] Communiqué No. 2026/10, Official Gazette, 3 April 2026, Article 11. https://www.resmigazete.gov.tr/eskiler/2026/04/20260403-10.htm
[5] TZOB (2025). Press release, 15 October 2025. https://www.tzob.org.tr/15-ekim-dunya-kadin-ciftciler-gunu-7/
[6] TurkStat (2026). ICT Usage Survey in Households and by Individuals 2026, bulletin 58006, tables by occupation. https://veriportali.tuik.gov.tr/tr/press/58006
[7] ILO, ILOSTAT, Employment by sex, economic activity and education, based on the TurkStat Labour Force Survey (2025).

Institutional capacity, infrastructure and smallholder focus

INSTITUTIONAL CAPACITY

Integrate smart farming modules into vocational curricula and extension; the Ministry's supported advisory scheme covered 709 agricultural advisers and 36,831 farms in 2025,[1] a channel for decision services. Universities have started "Precision Agriculture and Agricultural Robotics" degrees: all 120 places at four universities were filled in 2026.[2]

INFRASTRUCTURE

Neutral data infrastructure, reliable positioning corrections and rural connectivity are preconditions for sensors, task maps and autonomous machines. Demonstration farms can act as local innovation hubs.

SMALLHOLDER FOCUS

Tools must work on small parcels and through cooperatives. Türkiye has 6,364 agricultural development cooperatives with more than 650,000 members and 2,446 irrigation cooperatives that manage water jointly.[3]

5.2 Pilot adaptation models

PILOT MODEL	WHAT IT INVOLVES	BUILT ON (CHAPTER 3)
Drone and simulation training hubs	Training labs in vocational schools or extension centres combining online theory, simulator practice and supervised field flights; content in Turkish; drone rules of the civil aviation authority (SHGM) followed.	AgroPro, Drones4GREEN, AUA courses (GR); SilA (DE); Vinum (FR)
Irrigation decision kits	Pre-configured soil-moisture sensors or tensiometers on pilot farms, with simple irrigation advice by phone; linked to the 2026/10 grant for sensor-based irrigation.	Irrinov (FR), GS-Netz (DE), LIFE GAIA Sense (GR)
Satellite crop maps through advisers	Free Copernicus imagery turned into field maps and nitrogen or irrigation advice, delivered by extension agents and cooperatives.	Farmstar (FR), Netherlands Satellite Data Portal
Cooperative data platforms	Cooperative-led data sharing with standard consent forms and a sector data code; universities and start-ups provide analytics as a service.	JoinData and the agrifood data code (NL); Data-Agri (FR); EU Code of Conduct
Machines as a service	Shared robots, drones or autonomy kits run by cooperatives or contractors, with an independent field evaluation in the first seasons.	Vitibot contractor model (FR), LWG Bavaria (DE), NPPL+R (NL)

[1] Ministry of Agriculture and Forestry of Türkiye (2026). 2025 Annual Report (agricultural advisory support).

[2] Calculated from ÖSYM, 2026 YKS placement results, Table 4 (4 programmes, 120 places). https://cdn.osym.gov.tr/en-kucuk-ve-en-buyuk-puanlar-tablo-4-rps0lq-18092428.xlsx

[3] Ministry of Agriculture and Forestry of Türkiye (2026). 2025 Annual Report, Table 20 (agricultural organisations).

5.3 Implementation considerations

DIMENSION	TRANSFER STRATEGY
Legal	Align drone operations, autonomous machinery and agricultural data use with Turkish rules and the EU direction (Regulation (EU) 2019/947, the EU Code of Conduct on agricultural data sharing). Aerial spraying needs explicit authorisation.
Financing	Use existing instruments: the 70% grant for sensor-based smart irrigation (Communiqué 2026/10) and IPARD III support for machinery and equipment investments (base grant 60%, plus 5 points for applicants under 40, for livestock holdings under Measure 101).[1,2]
Technical support	Work with universities, digital innovation hubs and local companies for installation, calibration and maintenance; avoid dependence on one supplier.
Capacity building	Training of trainers, farmer field days on pilot fields, and simulation-based drone training for young farmers and advisers.
Equity	Gender-balanced and youth-oriented training, accessible formats for farmers with limited formal education, and cooperative models so that small farms are not left out.
Evaluation	Measure water, input and yield effects with a simple comparison (with and without the practice) and publish the results, including what did not work.

ALREADY IN PLACE IN THE PROJECT

Lavender pilot fields in five provinces, a training of trainers on smart and precision farming under climate change and water scarcity (Ankara and Polatlı, May 2026), young farmers' trainings in Sakarya (June 2026, covering drones and sensors) and Şanlıurfa (July 2026), a learning platform with free online modules, and the study visit to Athens (June 2026) provide the setting in which these pilot models can start.

[1] Communiqué No. 2026/10, Official Gazette, 3 April 2026, Article 11.

[2] Agriculture and Rural Development Support Institution (TKDK) (2026). IPARD III information guide, May 2026 (confirm rates in the current call). http://www.tkdk.gov.tr



Lavender planting on a project pilot field (based on a news photograph, 23 December 2024). AI-assisted illustration based on a real project photograph.

6 Conclusion

6.1 Innovation as a catalyst for resilient and sustainable agriculture

The cases in this report show what precision agriculture and smart farming look like when they work in Europe: satellite and sensor information turned into advice, data shared under rules that farmers trust, machines offered as services, and training that uses simulation before the field. In every theme, the technical tool succeeded when it was embedded in an organisation that farmers already knew: an advisory institute, a cooperative, a public agency or a training centre.

6.2 Key insights for scaling

- **Start small, scale smart:** modular services with one clear decision are the best entry point for pilot farms and regional training centres.
- **Trust is key:** farmers adopt digital tools when they control their data, take part in testing and can see results on farms like their own.
- **Human-centred design matters:** tools succeed when they fit local crops, languages and farm sizes, and when advisers can explain them.
- **Collaboration amplifies impact:** public-private-academic partnerships stood behind nearly every successful case.

6.3 Opportunities for cross-border leadership

Türkiye shares many conditions with southern Europe: water scarcity, small and fragmented farms, Mediterranean crops and an ageing farming population. The Greek partner VERDE, Greek institutions such as the Agricultural University of Athens, and the East Med cluster of the EU robotics network agROBOfood, which grouped Greece and Türkiye until 2024, offer a natural bridge. By piloting decision services, cooperative data rules and simulation-based training, and by publishing honest results, the project and its partners can become active contributors to Europe's digital farming future rather than only users of it.

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