# Pilot 6 – Agriculture

## Pilot Introduction

Viticulture is an important source of employment in Portugal. However, the growing lack of human labour to manage vineyards effectively has become a concern., namely in the Douro Demarcated Region (DDR), the oldest demarcated wine region in the world. Managing a vineyard requires a significant investment of workers’ time and energy.

This is a problem because human labour is essential in this region, where a mountain viticulture is practiced, that is, where the vineyards are located on steep slopes, in which modern machinery cannot manoeuvre.

In this sense, the intent of this agricultural pilot is to reduce workers’ physical stress to make this trade more attractive while, at the same time, to improve the consistency of grapes / wine production and to reduce the grapevine mortality rate. For this, a novel solution for high-performance sustainable management of the old, terraced vineyards of Quinta do Crasto (QDC), is expected to be developed that will be supported on advanced trustworthy digital technologies.

The goal is to: i) ensure that human workers remain central to the process, with AI and robotics serving as tools to enhance their capabilities; ii) use AI and robotics to assist personnel in their tasks, improving efficiency and accuracy; iii) use leverage data and AI insights to help workers make more informed decisions about vineyard management.

## Description of Use Cases

### UC-AGR-3: Transport of the grapes in a steep-slope vineyard during the harvest season

**Objective:**

To improve harvest efficiency and worker safety in steep-slope vineyards by integrating AI-powered grape transport and monitoring of worker fatigue. Automation reduces the need for manual carrying of grape boxes, alleviating physical strain, and optimizing harvest operations through intelligent scheduling and adaptive workload distribution.

**Scenario:**

Harvesting grapes in steep-slope vineyards requires workers to manually transport 22 kg boxes up difficult terrain, leading to fatigue and injury risks over 40-50 days of continuous work. To reduce strain, an AI-powered cargo drone will assist with grape transport, reducing the number of manual trips required.

Additionally, workers will wear IoT sensors that track fatigue, repetitive movements, and sun exposure. The system will analyse collected worker fatigue data to optimize task distribution and ensure sustainable harvesting conditions. Fatigue and transport efficiency data shall be integrated into a vineyard management system, allowing vineyard managers to adjust workload distribution as needed.

**Key Requirements:**

* Worker fatigue can be assessed using wearable sensor data, enabling informed adjustments in task scheduling where applicable (Shall).
* The AI system shall dynamically adjust transport task allocation at predefined intervals, ensuring optimized drone dispatch while allowing workers to validate and refine scheduling suggestions based on operational conditions (Shall).
* The system shall provide clear reasoning for its recommendations, ensuring workers understand why breaks or task adjustments are suggested (Shall).
* The system should provide vineyard supervisors with tools to optimize worker allocation and auxiliary equipment use, particularly when labour shortages impact demanding tasks (Should).
* The AI transport scheduling shall prioritize drone dispatch based on worker fatigue levels, harvest rates, and terrain constraints (Shall).

## Plan for Integration of Technologies

This section explains the envisaged use of the AI4Work technologies in each UC.

### UC-AGR-3: Transport of the grapes in a steep-slope vineyard during the harvest season

Several advanced technologies are required to promote the success of this use case:

* **Data collection and handling for AI/Robotics Services:** Wearable sensors track worker fatigue levels throughout the harvest and grape transport process. This data can be used to analyse physical strain, optimize task assignments, and enhance workplace safety.
* **Long-Term Adaptation** AI models and robotic systems can be updated periodically based on new data and user feedback to refine transport efficiency, adapt to vineyard conditions, and improve coordination between drones and workers.
* **Digital Twin:** A Digital Twin of vineyard logistics integrates grape transport dynamics, worker activity, and environmental conditions to support decision-making in harvest operations.
* **Context Awareness:** AI models can incorporate terrain conditions, weather data, and operational constraints to adjust drone performance and optimize transport decisions.
* **Sliding Work Sharing:** The system can dynamically balance transport tasks between drones and vineyard workers, improving workflow efficiency and resource utilization.

Figure . AI4Work Architecture adapted for the EP of the Agriculture Pilot – Use Case 3

## Initial Plan – Early Prototypes

In this section, the early prototype development milestones were identified, as well as the timeline showing the implementation stages of each early prototype.

### UC-AGR-3: Transport of the grapes in a steep-slope vineyard during the harvest season

**O3.1 Define worker fatigue monitoring and AI-assisted task allocation [March 2025]**

* Identify wearable IoT devices to track worker fatigue based on exertion levels, allowing AI to analyse fatigue trends and suggest task adjustments at predefined intervals.
* Establish fatigue thresholds to inform task balancing between drones and human workers.

**O3.2 Select and test cargo drone for vineyard transport [March 2025]**

* Choose a cargo drone with sufficient payload capacity and test flight stability in vineyard terrain.

**O3.3 Develop Digital Twin prototype for transport logistics [June 2025]**

* Create a Digital Twin to simulate grape transport scenarios, integrating:
* Drone activity
* Worker fatigue levels
* Environmental constraints (e.g., slope steepness, wind speed)

**O3.4 Implement AI-driven context awareness and Sliding Work Sharing [June 2025]**

* Train a system to factor in environmental conditions (wind, slope, weather) for adaptive drone transport planning.
* Develop Sliding Work Sharing, where AI assists but workers review and refine transport task assignments.