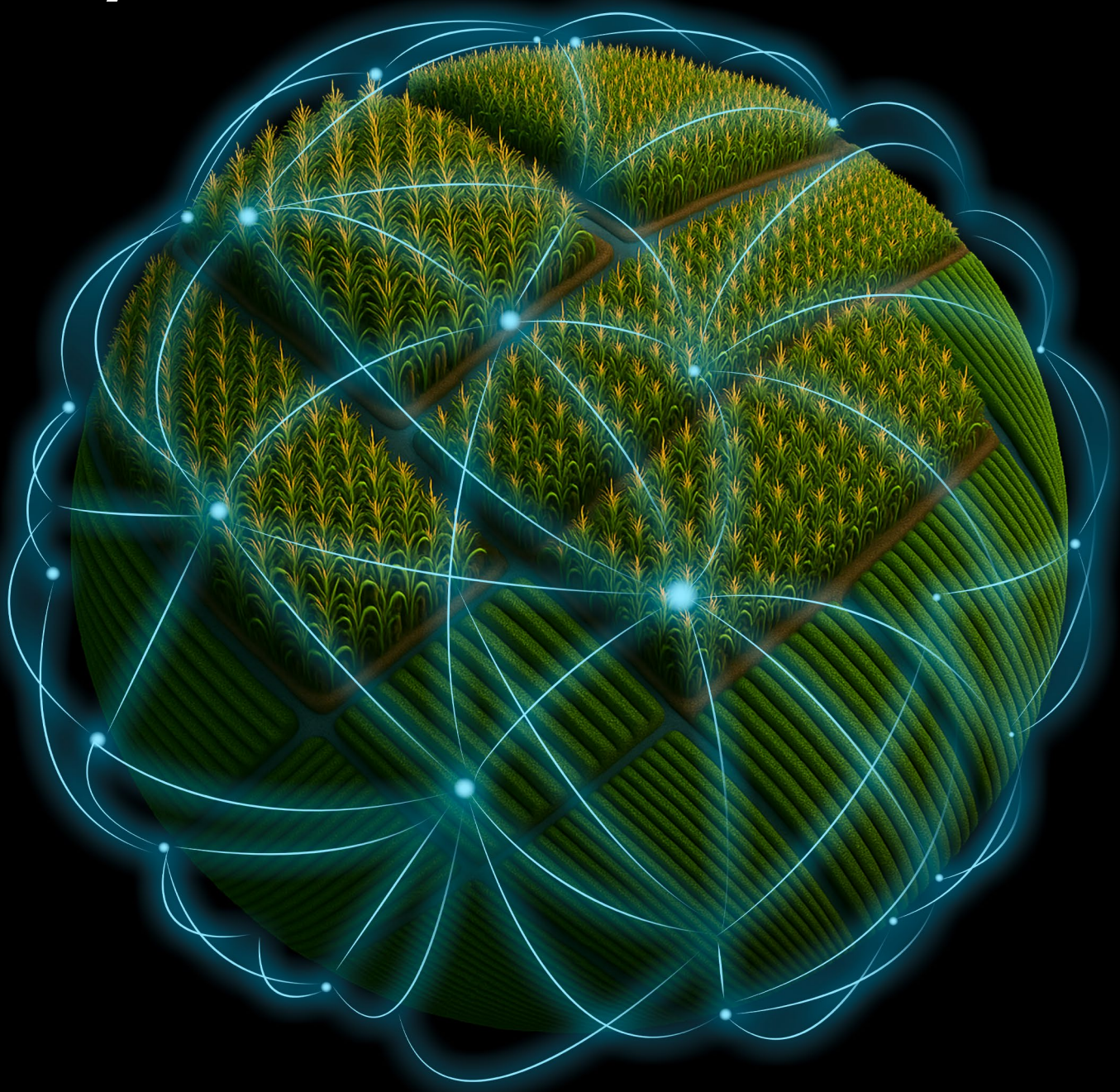
HydroMet



datasphere

Solution Brief: Irrigation Recommendation using the ET-model method.

KISTERS

Empowering decisions of tomorrow

Solution Brief:
Irrigation Recommendation using the ET-model method.

Water is one of the most vital natural resources. All life depends on it, and agriculture requires a reliable and predictable water supply. However, due to climate change, water availability has become increasingly uncertain. Droughts are lasting longer, and rainfall events are more intense. This leads to excessive runoff and reduced soil infiltration.

In this context of rising scarcity and unpredictability, it is essential for farmers and agricultural planners to understand current drought stress on crops and to be able to anticipate future irrigation needs with precision.

KISTERS has developed a suite of tools to support smarter irrigation decisions. One of these tools uses actual evapotranspiration (ETa) sensors to assess water demand with great accuracy. When ETa sensors are unavailable, KISTERS offers an alternative:
the ET-model method.

What is the ET-model method?
This method estimates the net evaporative water demand of a crop based on its location and type. It incorporates:

- Historical and forecast weather data (with historical data acting as pseudo-observations);
- Effective rainfall (i.e., the portion of rainfall that actually benefits crops).

It also considers any scheduled or default irrigation practices.

Where available, local sensor data can replace or refine the model-based inputs, improving accuracy.

Several well-known agricultural research institutions in Spain already use this methodology, and KISTERS has further enhanced it to include forward-looking forecasts.

How it works:

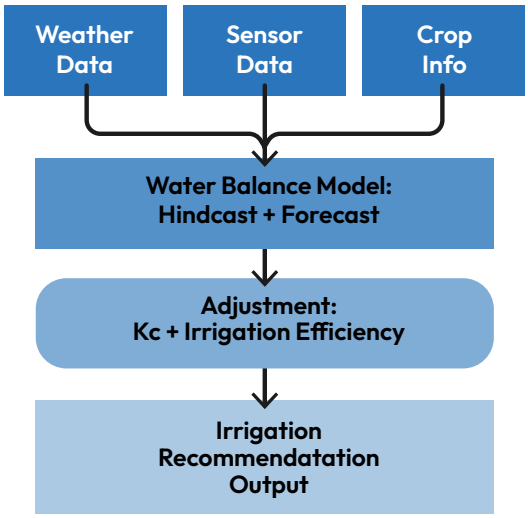


Figure: Irrigation Recommendation workflow

This flowchart shows how the KISTERS model processes weather data, crop information, and sensor inputs to calculate crop-specific irrigation needs – factoring in past water balance, evapotranspiration, and irrigation efficiency to produce a tailored recommendation.

The process begins with an examination of the recent hindcast period, which is a user-defined window of past days. During this phase, the model compares:

- Crop-specific potential evapotranspiration (ETc) and
- Effective rain and applied irrigation (if any).

If local sensors are available, ETc and effective rainfall can be calculated using on-site data. Otherwise, the model uses high-resolution weather analysis and short-range forecasts.

This provides a clear baseline of how much water deficit or surplus the crop has experienced recently.

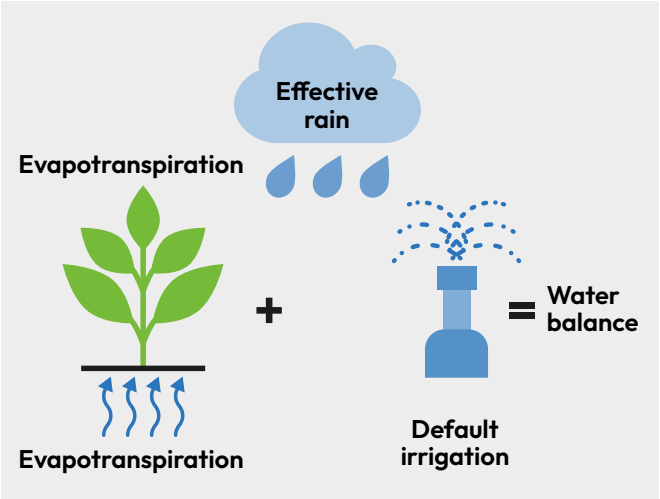


Figure: Understanding water balance

The model calculates how much water your crop needs by balancing evapotranspiration against effective rainfall and any default irrigation. This forms the foundation for both past (hindcast) and future (forecast) analysis.

The model then generates a forecast-based irrigation recommendation by projecting:

1) future ETc using the FAO56 Penman-Monteith equation adjusted for crop type and growth stage, and
2) expected rainfall converted into effective rain based on factors such as terrain slope, crop canopy, which depends on crop-type and phenological stage.

Since weather forecasts are inherently uncertain, the system supports multiple forecast models, enabling scenario testing and comparative planning.

Refining the Recommendation

KISTERS' system fine-tunes the irrigation recommendation by considering the following:

- Crop phenological stage (Kc values): For example, young corn needs significantly less water than corn at peak maturity.
- Irrigation method efficiency: Drip irrigation is more efficient than sprinklers or gravity-fed methods. The model accounts for these differences to prevent over- or under-watering.

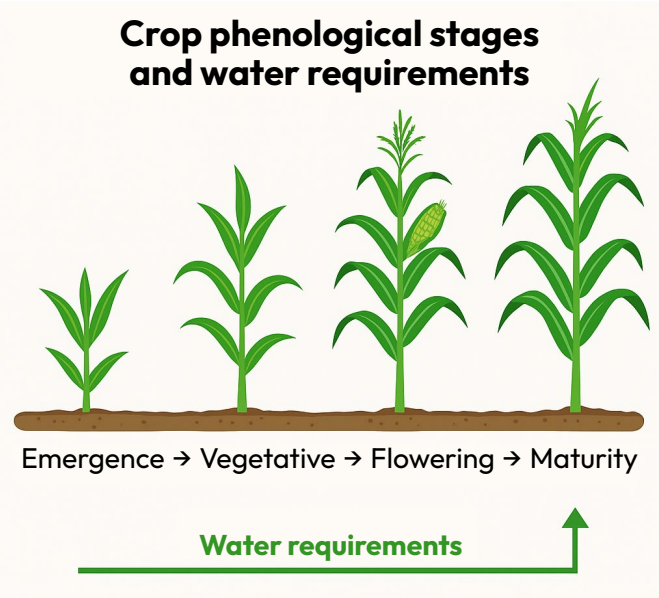


Figure: Water requirements across crop growth stages

Crop water needs increase as plants grow. The model accounts for phenological stage using Kc values to avoid over- or under-irrigation – adjusting recommendations to match the actual development phase of the crop.

The result is a highly specific recommendation tailored to:

- crop type
- its current development stage
- and the chosen irrigation method.

Scenario testing:
The KISTERS tool also enables "what if" simulations. Farmers can model common local practices, such as irrigating every fifth day or aligning with water access rights, and test how these practices impact outcomes.

These scenarios can be adjusted to account for irrigation efficiency and forecasted effective rainfall, making the tool practical and flexible in real-world contexts.

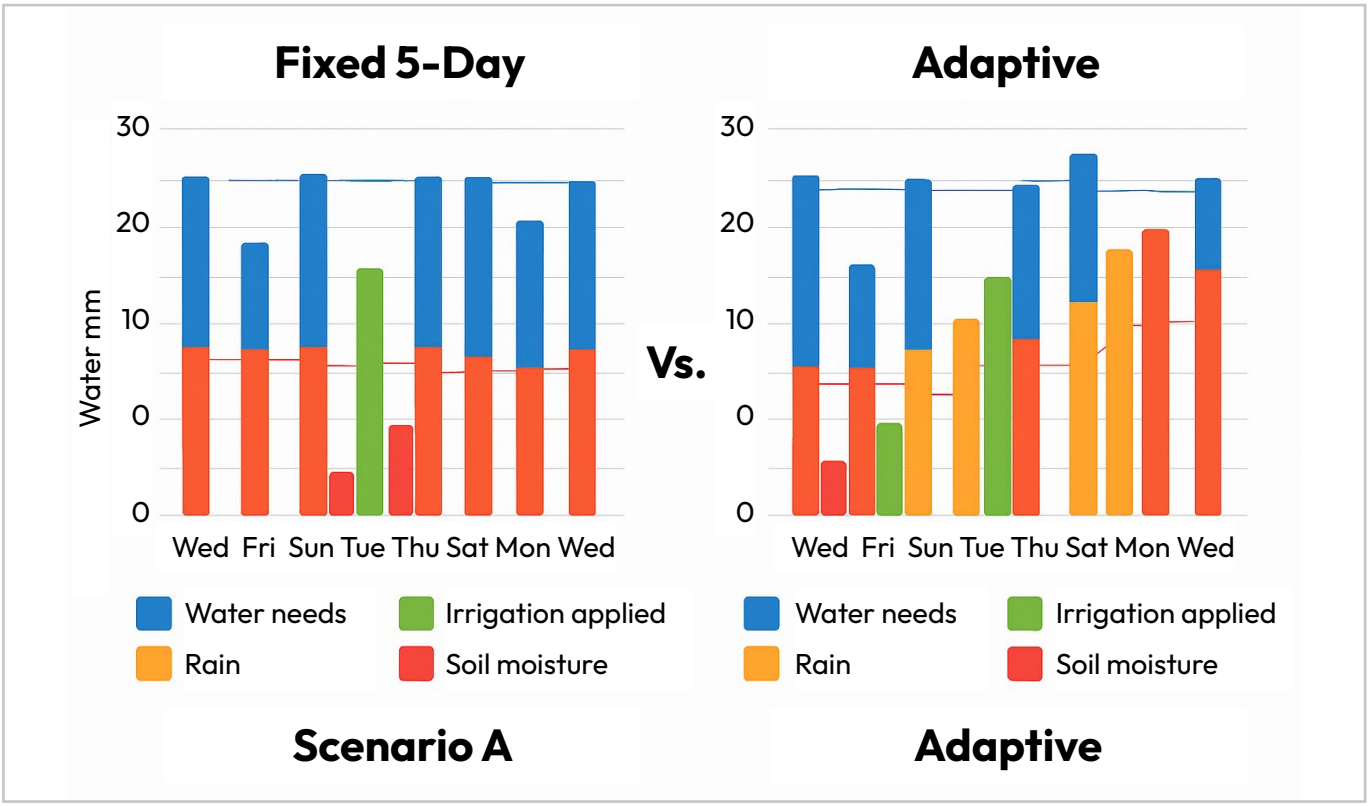


Figure: Fixed vs. Adaptive Irrigation scenarios

This comparison shows how a fixed 5-day irrigation schedule differs from an adaptive approach that adjusts to rain patterns and changing crop water needs. Adaptive scheduling typically improves water efficiency and soil moisture balance.

Example output:

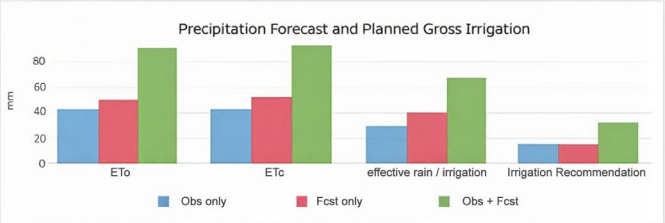
Below is an irrigation recommendation for cauliflower in Murcia based on the NCEP GFS weather forecast model with 95% irrigation efficiency. The output includes a 14-day daily breakdown of evapotranspiration, rainfall, and irrigation needs, combining both observed and forecasted data.

This output provides tabular and graphical insights to help users visualize crop water stress, applied irrigation, and expected water requirements over time.

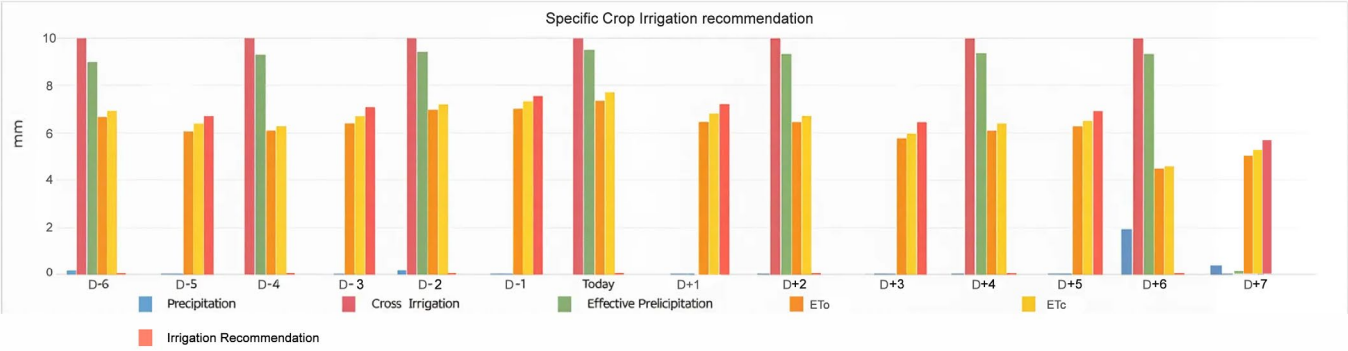
Irrigation Recommendation

Location	Grop	Date of Emergence	Forecast Model	Time of Forecast	Irrigation Methed Efficiency
Murcia	Caulflower	1/05/2024	NCEP GFS	21/06/2024, 08:00	95.0 %

	Obs only	Fcst	Obs + Fort
Eto in period / (mm)	40.4	48.1	88.5
Eto in period / (mm)	41.8	50.4	92.3
Effective rain / irrigation in period (mm)	28.5	38.0	66.5
Irrigation Recommendation (mm)	14.0	13.2	27.2



	Sat	Sun	Mon	Tue	Wed	Thu	Fri	Sat	Sun	Mon	Tue	Wed	Thu	Fri
	06/15	06/16	06/17	06/18	06/19	06/20	06/21	06/22	06/23	06/24	06/25	06/26	06/27	06/28
	D-6	D-5	D-4	D-3	D-2	D-1	Today	D+1	D+2	D+3	D+4	D+5	D+6	D+7
Precipitation (mm)	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.4
Gross irrigation applied/planned (mm)	10.0	0.0	10.0	0.0	10.0	0.0	10.0	0.0	10.0	0.0	10.0	0.0	10.0	0.0
Effective Precipitation (mm)	9.5	0.0	9.5	0.0	9.5	0.0	9.5	0.0	9.5	0.0	9.5	0.0	9.5	0.0
ETo (mm)	7.0	6.3	6.1	6.5	7.3	7.2	7.6	6.7	6.7	5.5	6.4	6.4	4.1	4.8
ETc (mm)	7.2	6.5	6.3	6.7	7.6	7.5	8.0	7.0	7.0	5.8	6.7	6.7	4.3	5.0
Irrigation Recommendation (mm)	0.0	4.4	0.0	3.7	0.0	5.9	0.0	5.7	0.0	3.4	0.0	4.0	0.0	0.0



Key benefits of the KISTERS datasphere Irrigation Recommendation Module:

- Quickly assess crop water stress and respond promptly.
- Avoid over- or under-irrigating by adapting recommendations to crop type and growth stage, which saves water, time, and money.
- Test and compare multiple scenarios using different weather models and irrigation schedules to find the most efficient and practical approach.

HydroMet

Irrigate smarter.
Save water.
Grow better.

With datasphere Irrigation Recommendation Module.

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Who are we?

We're KISTERS – and for over 60 years, we've specialised in helping our customers collect, analyse and share the environmental data that will shape the future.

Through innovative, digitally-focused solutions, we develop advanced systems that enable our customers to capture and manage information at a higher quality than ever before. So they can make the solutions our world needs to thrive.

Discover the Irrigation module

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Empowering decisions of tomorrow