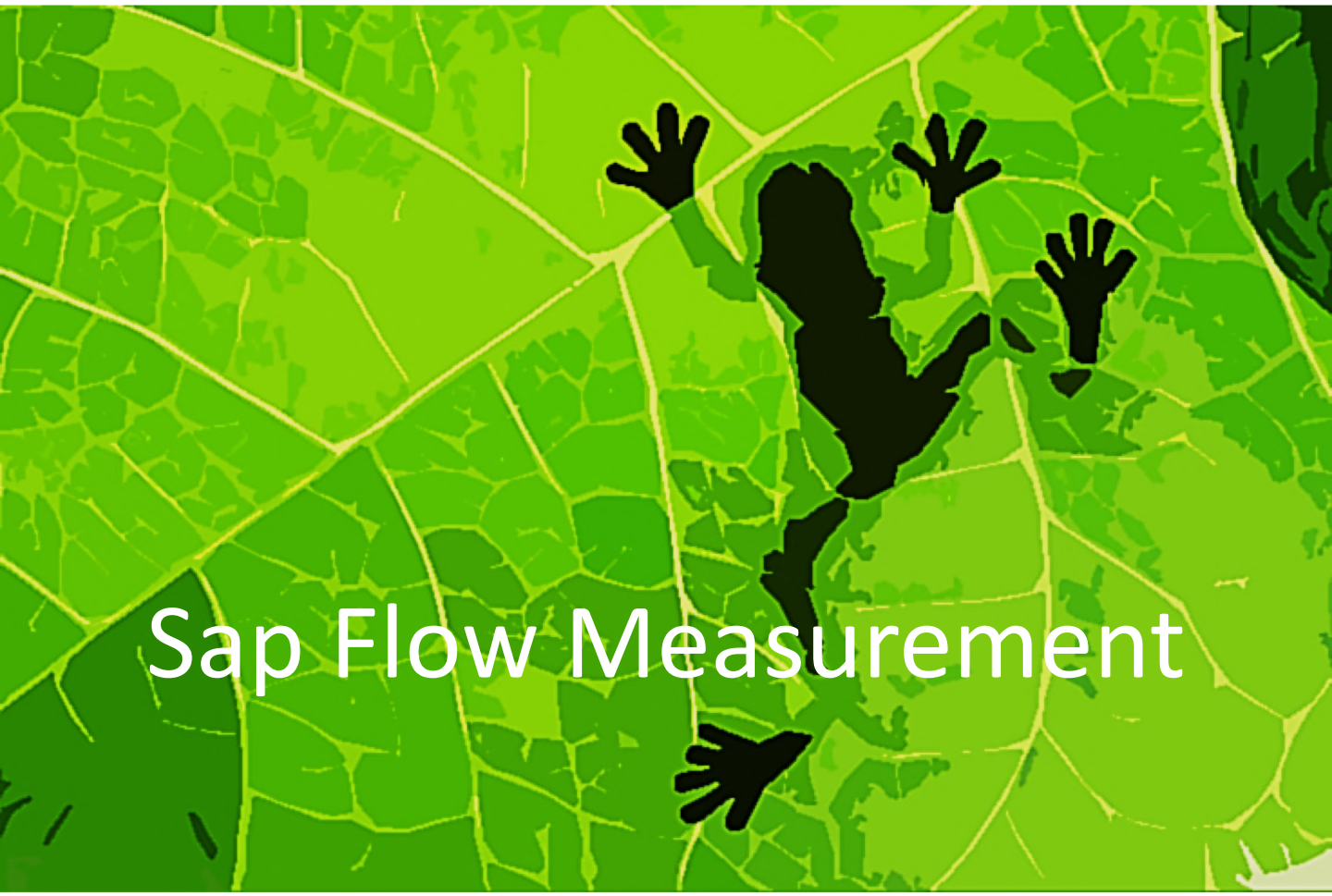
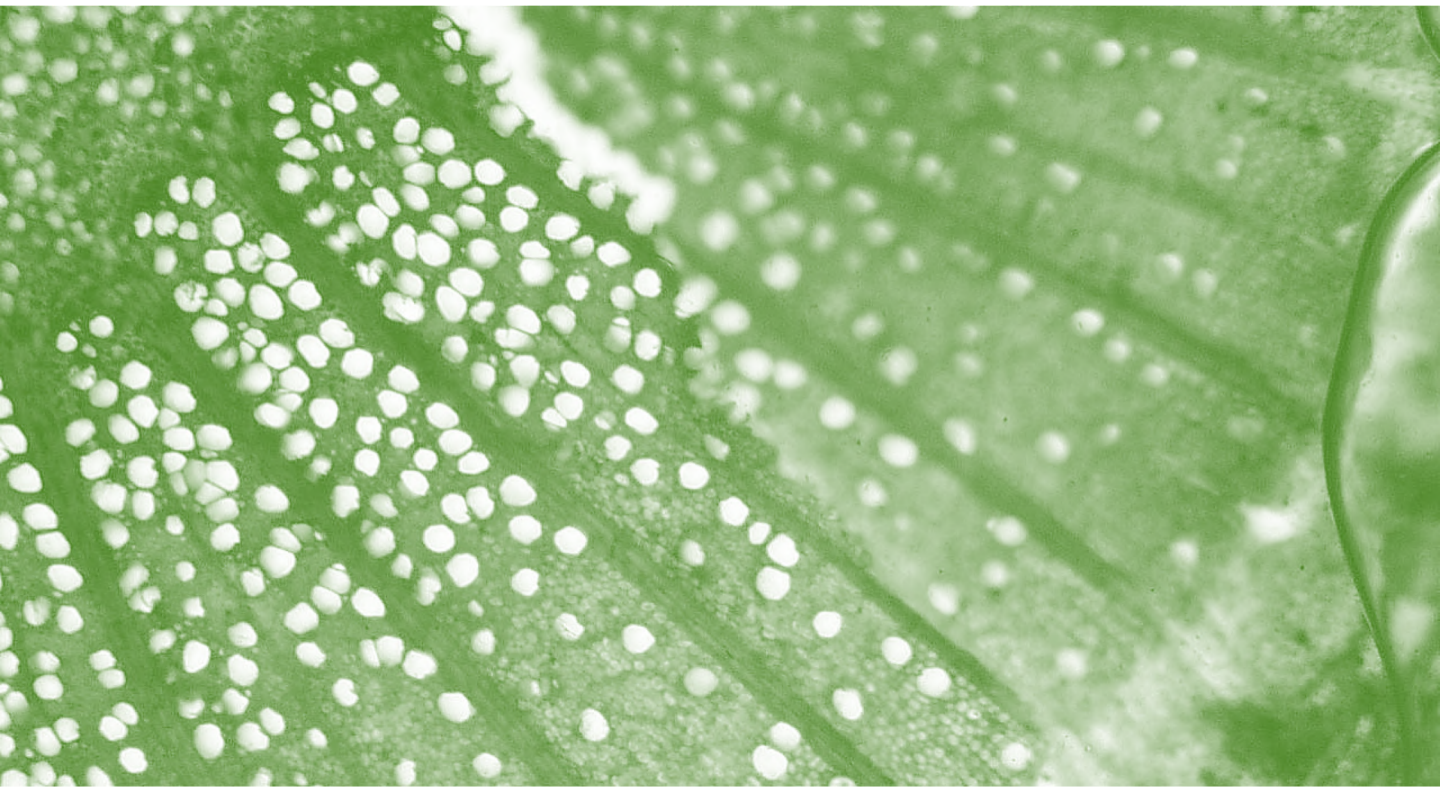


Kisvin Science

What's Sap flow?

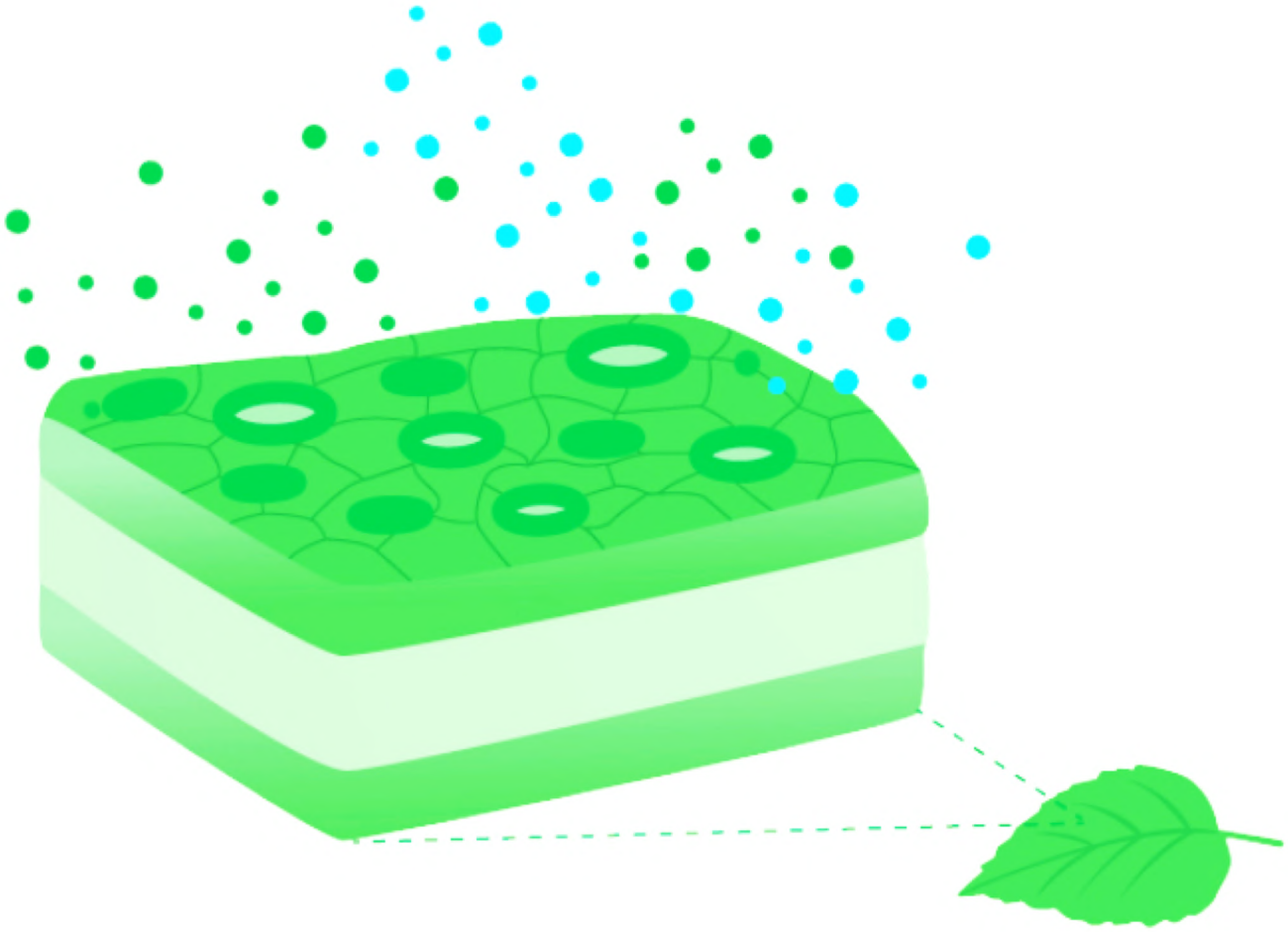
The sap flow that flows through a series of xylems conduit that extends from the roots to the stomata distributed on the back of the leaves is called sap flow. The size of the conduit and its distribution within the stem / stem / branch cross-sectional area vary from plant to plant. The sap flow in the tree body is driven by transpiration, and its flow rate changes depending on the atmospheric opening and the stomatal opening that changes due to solar radiation.



The stomatal opening corresponds to the opening of the faucet in the water supply, and changes depending on the amount of light received by the leaves, wind speed, and humidity. VPD is equivalent to the water pressure that generates the water flow (actually, the negative force that pulls water from the leaves in a dry atmosphere opposite to the water supply).

Leaf surface gas exchange and photosynthesis

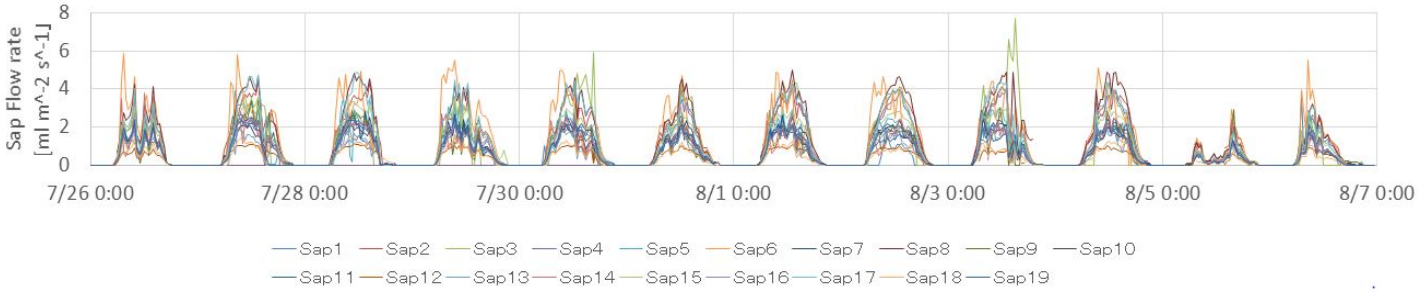
Plants release water vapor through transpiration from the many stomata distributed on the backside of the leaves, and at the same time absorb carbon dioxide gas necessary for photosynthesis. The exchange of water vapor and carbon dioxide in the stomata is called “gas exchange”, and the efficiency is called gas conductance. The gas conductance is equivalent to the amount of transpiration divided by VPD, and there is the high linear correlation between the gas conductance and the photosynthetic rate.



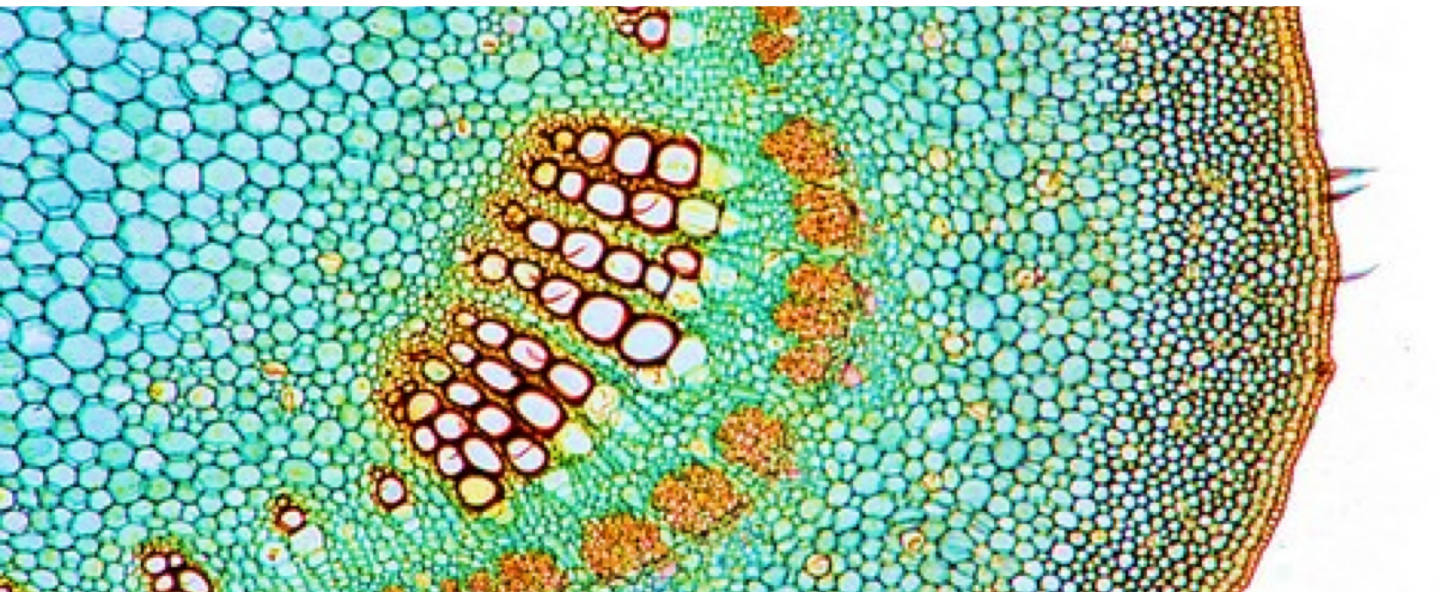
The gas conductance is equivalent to the reciprocal of the stomatal resistance, and the nominal and physiological meaning changes depending on the stomatal conductance, shoot conductance, canopy conductance and the scale to be measured.

Change in sap flow over time

The temporal pattern of sap flow varies depending on environmental factors. The main factors are temperature, atmospheric humidity, solar irradiance (or PAR/PPFD), and soil moisture. The sap flow rate is almost equal to the amount of water absorption, and it can be regarded as equal to the transpiration rate if it is about the size of a herbaceous plant. The sap flow basically flows from the root to the leaves, but it has been reported that backflow may occur locally in the tree. Night transpiration may also occur.



The sap flow amount could be calculated from the sap flow velocity by integrating into the xylem vessel area corresponds to the sap flow rate. However, the sap flow rate is not uniform in the cross section of the stems and branches. That is, the flow rate obtained by scaling up the sap velocity is not equivalent to the sap flow rate reflecting the actual canopy structure.



Heat balance sap flow sensor

A sap flow sensor using the stem heat balance method, which can measure sap flow of stem / branch only non-destructively against other destructive principles. A thin film heater is wound around the measurement site, a known amount of heat is applied to the plant body, and the sap flow rate is obtained by solving the heat balance equation established at the measurement site by a fine temperature sensor placed around the heater.

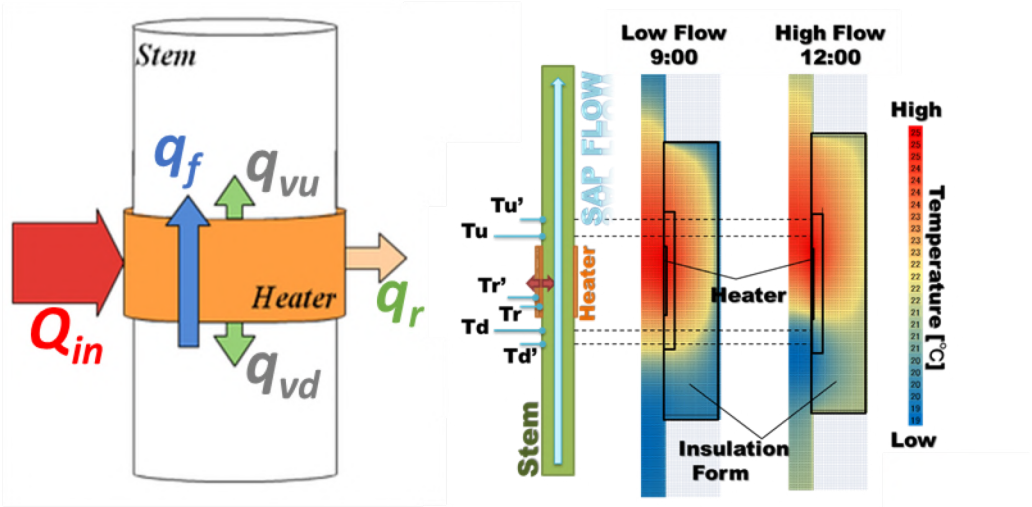
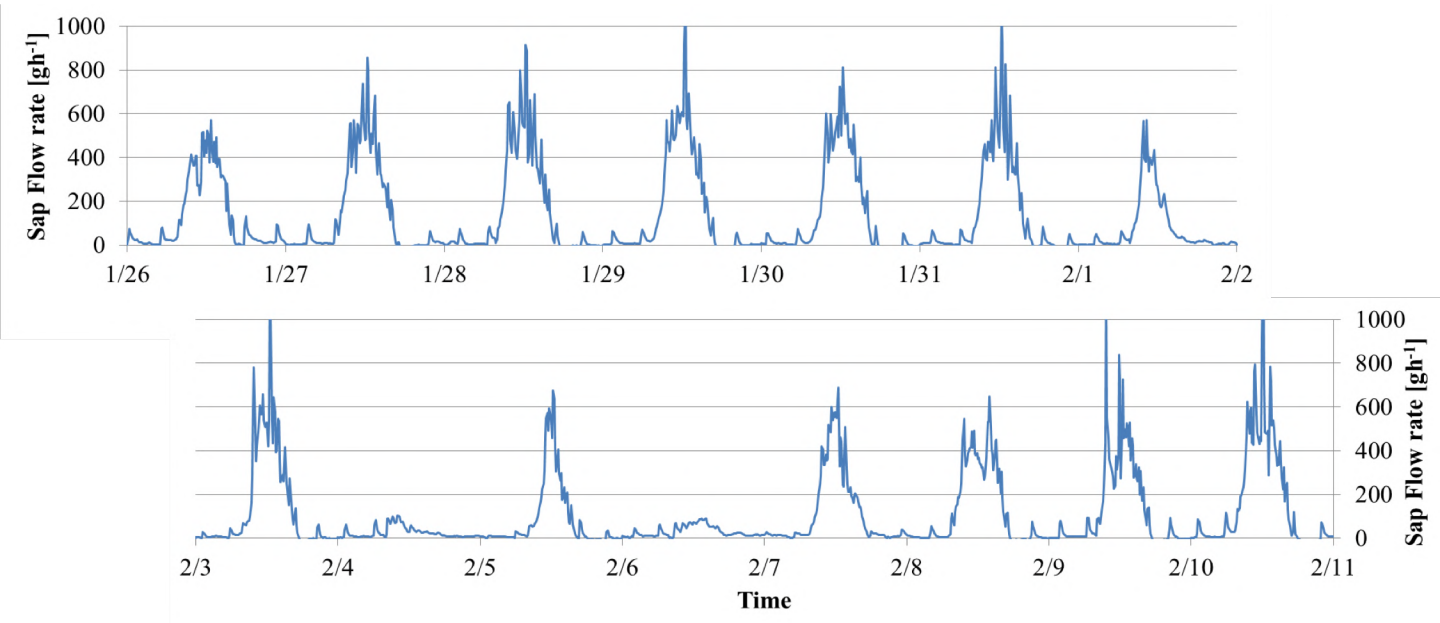


Diagram of the Stem Heat Balance Method



Example of sap flow monitoring under a vinyl house cultivating tomatoes in winter season.

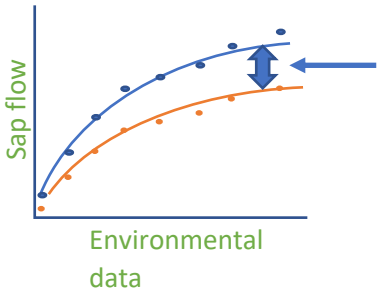
Sensor type

Our sap flow sensor is a non-destructive sensor that measures the flow rate through the conduits of plants. Use in combination with environmental sensors (temperature, humidity, solar radiation, etc.) to analyze the physiological condition of plants. There are two types of sap flow sensors: Thermopile type(Tp) and Thin Film Thermistor(TFT) type. TFTtype can also be used as a heat pulse sensor if you need.

Sensor type	Thermopile(Tp) type	Thin Film Thermistor (TFT) type
Exterior appearance		
Corresponding stem diameter	7 to 30mm *Only 10mmΦ can be sold now	7 to 30mm *Negotiable except for current 10mmΦ now
Heater supply voltage	1.5 to 12V	1 to 12V
Supported data logger	A high-end logger with a thermocouple-compatible channel. We accept built-in support. (We are developing a dedicated low-cost logger. Coming soon!)	A commercial data logger with a 10 bits resolution or more for Single end. We can accept on demand. (We are developing a dedicated low-cost logger. Coming soon!)
Selling price	Please contact	Please contact

Utilization scene

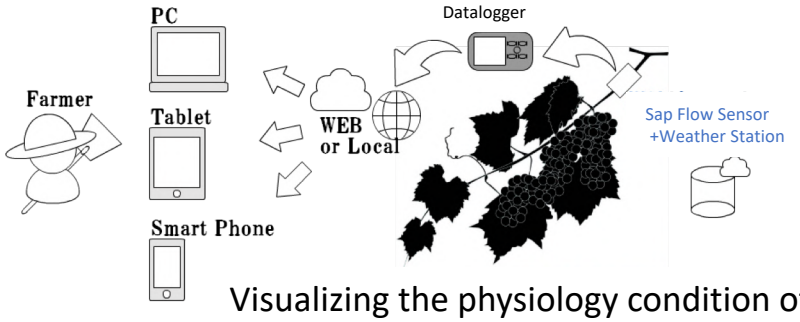
- Comparison with other field data (Terroir element)
- Comparing time series data over years (Vintage elements)



Quantitative comparison between field environments and vintages are possible.

- Scanning of expert's irrigation technique

New farmers can learn advanced irrigation technology in a short time.

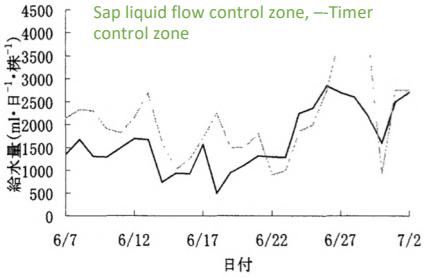


Visualizing the physiology condition of plants.

- Precisional irrigation (Water saving, Water stress check and stress control)

Sap Flow Sensor is a powerful tool to conserve water resources in arid/semi-arid areas

The amount of water absorbed by plants can be limited.



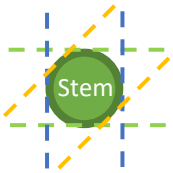
- Optimal training data for AI / Verification of environmental control by AI

It is possible to verify how plants respond to environmental control by AI.

Sap Flow Sensor provides the best dinner for AI.

Case Study 1
Tomato

-Install sap flow sensor at least 20 to 30 cm from the ground.
-Choose a Straight part.
-Choose a cylindrical place with as few aerial roots as possible.
-As long as possible between nodes (between leaves).

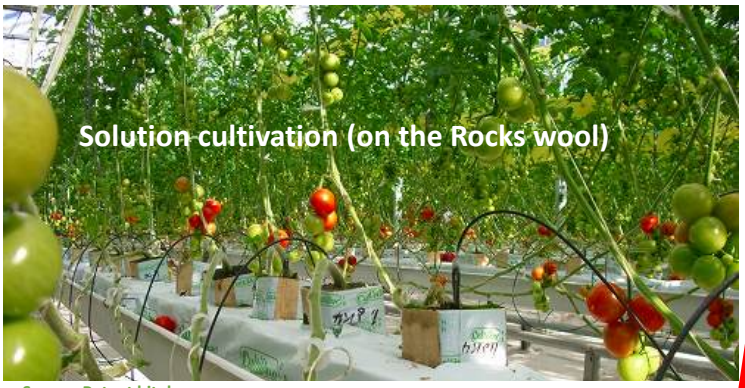


-The transpiration (= water absorption) amount of the whole canopy (per individual plant) can be obtained by placing sap flow sensor below the lowest leaf.
-It can be installed at the location 1 or 2 in the figure, but 1 is a little more complicated to waterproof, because moisture tends to enter the sensor position by spraying chemicals or the like.
-When selecting the sensor size, measure the diameter of the intended installation position by using a caliper at three different angles.

Various cultivation systems

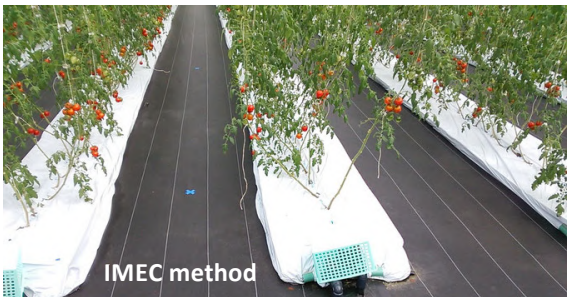
Differences in media systems, irrigation schedules, and environmental controls can be clearly obtained as quantitative values. Exquisiteness such as leaf shoveling also appears as variation in individual differences. It is the primary water resistance caused by the root system that has the greatest effect on the measured value.

Soil moisture measurement, Easy

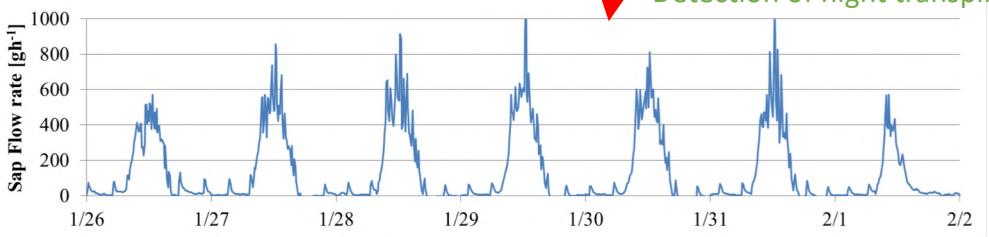


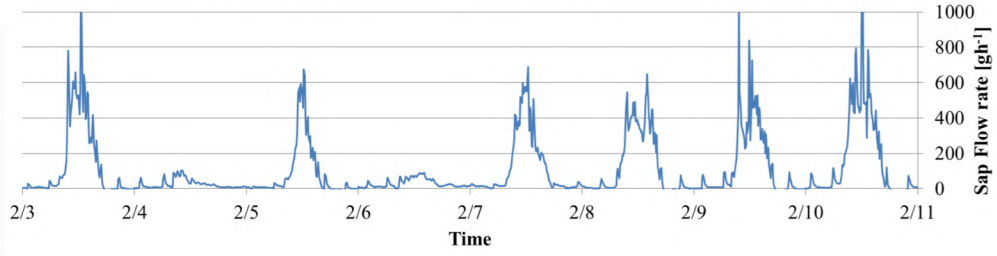
Source: Potent hit days

Soil moisture measurement, Difficult

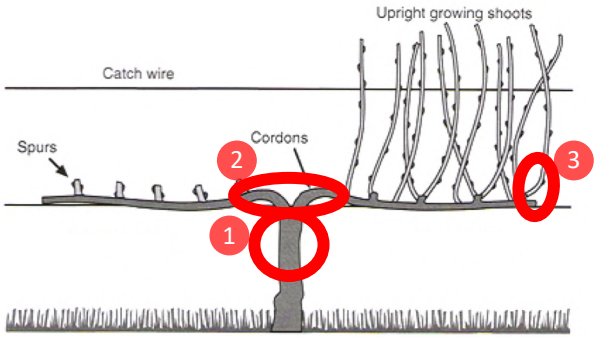


Detection of night transpiration due to heating





Case Study 2
Wine grapes



When used for vigor evaluation of vines in the field,
there are three possible locations to install.

1. Main trunk
2. Branche junction
3. Base of an annual shoot at the tip side

*When installing at the main trunk, leave 20 ~ 30 cm or more from the ground. It is impossible to measure when the trunk exceeds 5 cmϕ.
*Choose a straight part.
*Choose a cylindrical part with as few aerial roots as possible
*The transpiration (= water absorption) amount of the whole canopy (per individual plant) can be obtained by placing sap flow sensor below the lowest leaf.
*In the case of long-term measurement, waterproofing is a little cumbersome because it is easy for moisture to enter the sensor during chemical spraying or raining.
*When selecting the sensor size, measure the diameter of the intended installation position by using a caliper at three different angles.
*Peel off the bark of the installation position carefully so as not to damage the phloem.

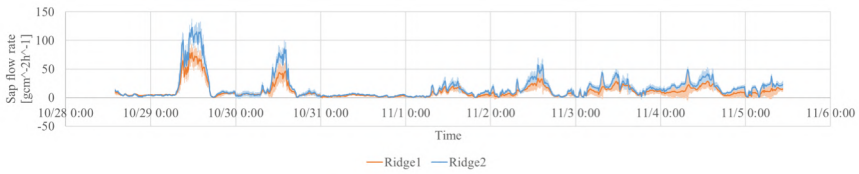
Performance

-Soil culture tomato in vinyl house

-Undetectable correct water condition with soil moisture sensor
-Monitoring water absorption of plants.
-Yield 12% UP
by optimizing irrigation amount
-The number of flower buds increased.
-Quality is able to maintained.

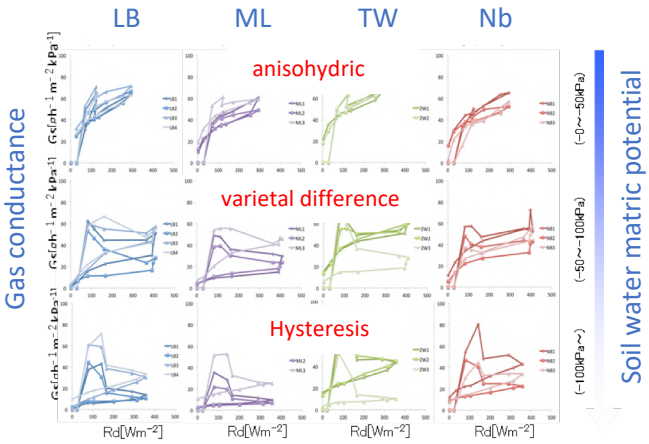
-Asparagus

-18% increase in yield
by optimizing irrigation amount.



-Wine grapes

-Achieved **60%** water savings by optimizing irrigation amount and timing
-The difference in vine vigor between cultivars and clones can be evaluated.
-Avoids excessive water stress



[Other case studies]

[Tokyo University] Sap flow sensors are used for research on the flowering characteristics of lotus.

It is used for research to find the optimum irrigation stress in mango orchards in Thailand.

JV Trellis was developed as a labor-saving pear cultivation technique at the Kanagawa Prefectural Agricultural Research Center. Sap flow sensor are used as an index to evaluate tree vigor.

Many wineries aiming for better viticulture have begun to use the sap flow sensor as an index to evaluate tree vigor and maintain yield by precise irrigation.

Visualization of plant physiology

It can be installed if there are cylindrical branches / stems. It can be applied widely from herbaceous plants such as vegetables to woody plants such as Fruit Trees and vines. In principle, this is not applicable to plants without stems such as spinach. Dynamic physiological responses that reflect various plant shapes (phenotypes) can be measured. We provide measurement plan based on the latest knowledge of plant physiology and ecology, and help you acquire data according to your purpose, from actual cultivation to science. Please feel free to contact Kisvin Science.

Kisvin Science
https://www.kisvin-science.com/
info@kisvin-science.com