APPLICATION STORY

US DEPARTMENT OF AGRICULTURE RELIES ON FLIR CAMERAS TO STUDY WATER-STRESSED CROPS.

In the world of agriculture, farmers have always been searching for ways to produce more crops and at the same time use less water for irrigation. Today, one of the stakeholders who is heavily involved in the research on irrigation and water management is the US Department of Agriculture (USDA). In their efforts to quantify water stress and study water productivity, researchers at the USDA are relying on thermal imaging cameras from FLIR Systems.

Compare it to watering a house plant. When a plant receives inadequate water supply, it will become 'water-stressed', which you will probably notice by the withering leaves. On a larger scale, farmers need to provide sufficient water supply for their crops, so they will have as many marketable crop products as possible. At the same time, they need to take into account climate variability and other risks, such as low water reservoirs, decreasing aquifers (underground water layers) and water right issues between states.

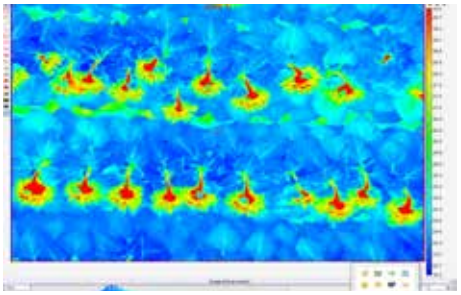
At the US Department of Agriculture, researchers are looking into ways for farmers to be more productive by using less water. They do this, among other things, by deliberately imposing stress on crops and monitoring the water stress, hereby taking into account a wide variety of factors, such as irrigation, precipitation and soil conditions. The ultimate goal is to be more productive and find alternative (more productive) ways of irrigation management. An example is 'deficit irrigation', an optimization strategy in which irrigation is applied during drought-sensitive growth stages of a crop. Outside these periods, irrigation is limited or even unnecessary if rainfall provides a minimum supply of water.

MONITORING CANOPY TEMPERATURE

The state of Colorado is a place where corn is king. But also crops like wheat and sunflower are typical for this area. Near their headquarters in Fort Collins (CO), the USDA Water Management Research Unit has shaped a so-called Limited Irrigation Research Farm (LIRF), consisting of 96 corn and sunflower plots of 9 by 44 meters. In these test fields the USDA team is applying 12 different irrigation treatments.

The FLIR A655sc provides 14-bit data up to 50 frames per second at full frame 640 × 480 resolution.

The Limited Irrigation Research Farm (LIRF) consists of 96 corn and sunflower plots of 9 by 44 meters. In these test fields the USDA team is applying 12 different irrigation treatments. While applying several irrigation treatments, the USDA is monitoring these crops in three different ways: at plant level, remotely by satellite and by means of ground-based remote sensing.



Thermal images captured by the FLIR A655sc present clear temperature differences between the flower head and the leaves, and between the leaf veins and the rest of the leaf.

Dr. Kendall DeJonge, agricultural engineer at the USDA, illustrates the research project in more detail: "While applying our several irrigation treatments, we monitor our corn and sunflower crops in three different ways: at plant level, remotely by satellite and by means of ground-based remote sensing. It's in the latter way that we use thermal imaging cameras from FLIR."

The most established method for detecting crop water stress remotely is through the measurement of a crop's surface or canopy temperature. The correlation between surface temperature and water stress is based on the assumption that as a crop transpires (i.e. sweats), the evaporated water cools the leaves below that of air temperature. As the crop becomes water stressed, the leaves will start to curl and transpiration will decrease. And thus, the leaf temperature will increase.

Next to permanent IR thermometer installations, the test field is also monitored twice a week by a GPS-referenced tractor, fully equipped with sensor material, including a FLIR A655sc camera, an RGB camera, an IR thermometer and a multi-spectral camera. All this equipment is attached to a boom that has been mounted on the tractor.

THERMAL IMAGING MAKES A DIFFERENCE

"We had been using IR thermometers before, but although these tools are affordable, they do not provide an image," says Dr. DeJonge. "That's why we realized at the start of this project that we needed a thermal imager. We definitely required high resolution, because we wanted to be able to look close enough and clearly see the difference between water-stressed plants and plants with sufficient water supply. We also wanted to clearly separate plant temperature and ground temperature and see the difference between shaded leaves and non-shaded leaves. After receiving a demo by a FLIR representative, we evaluated some high-resolution camera models. The FLIR A655sc research camera turned out to be the best fit for our project, because it easily met all our requirements."

HIGH-RESOLUTION, SCIENCE-GRADE IMAGING

The FLIR A655sc provides 14-bit data up to 50 frames per second at full frame 640 × 480 resolution. "We are very satisfied with the image quality of the FLIR A655sc. In our thermal images of sunflowers, we can clearly see the flower head that is hotter and the leaves that are 5 degrees colder. But also more in detail, we can see that the veins of the leaf are hotter than the rest of the leaf. This is highly quantitative data."

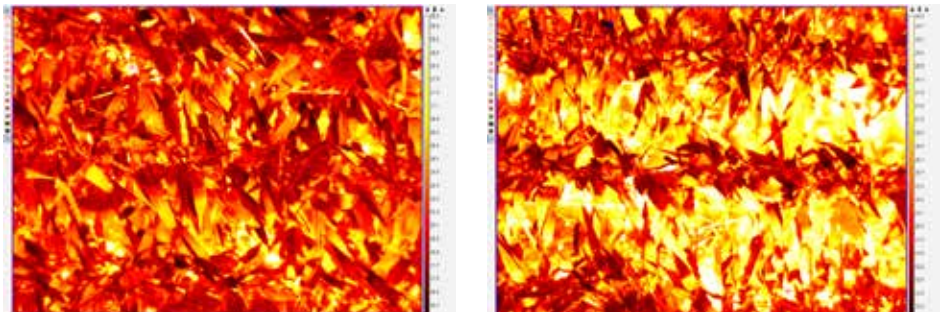
Next to a FLIR A655sc camera, the USDA team also makes use of an RGB camera, an IR thermometer, a multi-spectral camera and a GPS. All this equipment is attached to a boom that has been mounted on the tractor.

"The FLIR camera has also proven to be very robust. While we are driving our tractor through the test fields, it can be hot and dusty sometimes, but the camera has done very well throughout our period of use."

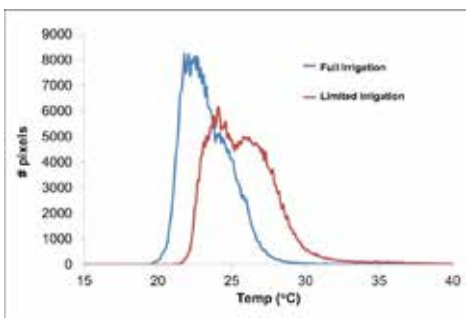
WELL-INFORMED IRRIGATION DECISIONS

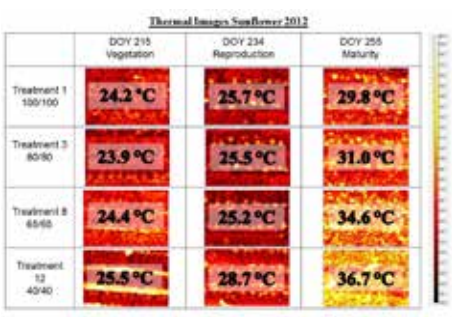
As an indispensable means of data collection, the FLIR thermal imaging camera has been a major contributor to the USDA Water Management research program. "We have been using the thermal imaging cameras for three years already and have been able to build an extensive data set. Based on the results which the thermal imaging camera from FLIR has provided us, we will be able to make better informed decisions on irrigation."

Research facilities like the USDA make use of advanced FLIR camera models. However, farmers could as well make use of thermal imaging themselves. Dr. Kendall DeJonge: "We also see a future for farmers that can use handheld thermal imagers to evaluate water stress on their own."



A thermal image clearly shows the difference between crops with full irrigation treatment (left) and limited irrigation treatment (right).





Several irrigation treatments are compared throughout the crops' various growth stages.

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