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WHEN MEASUREMENTS MATTER

South Africa: Sustainable Solutions for Farms

Developing sustainable water and energy solutions

Windbreak hedges

International partnerships for sustainable innovations

Improved water use in agriculture is essential to successfully adapt to climate change. In the FarmImpact project, German and South African partners combine technical solutions with ecological approaches to investigate the effects of windbreak hedges on the microclimate and productivity of wine and fruit growing in South Africa's Western Cape region.

South Africa faces greater challenges in the coming decades regarding climate change and its negative impact on agriculture, viticulture, and fruit growing. Agroforestry systems can contribute to the adaptation of agriculture to climate change. The research project "Agroforestry in Southern Africa - new pathways of innovative land-use systems under a changing climate" (ASAP) targets the application of trees in agricultural landscapes as a suitable response to the impacts of climate change. The project contributes to the research program "SPACES II – Science Partnerships for the Adaptation to Complex Earth System Processes in Southern Africa" to establish collaborative research projects between German, Namibian, and South African research institutions and universities. The program intends to contribute to the formulation of science-based recommendations for Earth system management and to ensure the

Case Study Summary

Application
Adapting to climate change

Location
Western Cape, South Africa;
Müncheberg, Germany

Products Used
HFP01-L, SN500SS, CS655, 03002-L, CR1000X, HygroVUE5, CR800

Contributors
Campbell Scientific Africa (CSAF)

Measured Parameters
Heat and energy balance, leaf gas exchange, photosynthesis, wind speed

Related Website
SPACES II – Science Partnerships for the Adaptation to Complex Earth System Processes in Southern Africa CLIENT II International Partnerships for Sustainable Innovations

sustainable use of the multiple ecosystem services of the region. SPACES II is funded by the German Ministry of Education and Research (BMBF).

Investigating agricultural water use

Water scarcity is one of the biggest challenges in South Africa, along with the effects of climate change, human vulnerability, and the loss of biodiversity and ecosystem functions. Agriculture in particular is threatened by pronounced dry seasons and water scarcity. As the center of wheat, wine, and fruit farming, the Western Cape is hugely important for the nation's food security. In addition to this, South Africa has been a major exporter of agricultural and forestry products to Europe for many years.

Dr. Maik Veste from the Centre for Energy Technology Brandenburg (CEBra) in Cottbus (Germany) and Dr. Roger Funk from the Leibniz Centre for Agricultural Landscape Research (ZALF) in Müncheberg (Germany)—in cooperation with Kerry-Anne Grey and Guy Midgley from the Department for Botany and Zoology at Stellenbosch University (South Africa)—are investigating the tree-crop interactions in citrus orchards and vineyards in the Stellenbosch area. The objective is to use the discovered environmental benefits to support the use of agroforestry systems as an innovative, multi-purpose land-use management practice, which needs to be integrated into agricultural landscapes. Thus, typical agroforestry systems will be systematically investigated to determine the effect of the trees on the radiation and heat balance of the adjacent annual and permanent crops. In this context, individual trees, windbreaks, or even smaller forests can have a favorable effect on the surface temperatures of the surroundings, which then has a particularly positive influence on the heat and energy balance of the adjacent crops. For this purpose, Campbell Scientific weather stations, equipped with Apogee Instruments' net radiometers, carry out microclimatic measurements to determine the effects of the trees on crop evapotranspiration and to monitor the intensive spatial and seasonal variances of the radiation balances.

In addition to measurements provided by sensors from Campbell Scientific and Apogee Instruments, a number of leaf-level gas exchange and photosynthesis measurements were taken to assess plant stress and photosynthetic capacity. The temporal and spatial monitoring of the ecophysiological capacity and its development is measured using Normalized Vegetation Index (NDVI) and Photosynthetic Reflectance Index (PRI) spectral sensors. These measurements record the photosynthetic capacity and stress state of the plants in the stands during the respective vegetation period. Previous measurements in a vineyard have shown positive effects on the reduction of wind speed and evapotranspiration. According to Dr. Veste, with reference to a control station in the open field, the mean wind speed from the hedgerow at canopy level (approximately 18 m [59.1 ft]) was reduced by 39% over the summer growing season. When applying empirical crop-specific Kc values for well-irrigated grapes, the reduction of evapotranspiration was 18.8% over the summer growth period, according to Dr. Veste. The current investigations will focus on the interaction between wind speed, radiation balances, and heat stress. More data regarding the effects of wind on crop physiology and heat stress will be collected.

The use of tree shelterbelts is a suitable eco-engineering approach to reduce water consumption and to enhance water saving in vineyards, orchards, and crop fields. Meanwhile, similar experiments are being installed in Müncheberg, Germany. This will allow a unique cross-continental research approach to understand the tree-crop interactions under different climatic conditions and to facilitate scientific exchange on climate change in agricultural systems on both continents.

Windbreak hedges and controlled irrigation

One of the main goals of the windbreak strip is to reduce the water requirements of agricultural crops. These protective strips create diverse field areas that have different evapotranspiration properties and a correspondingly lower need for irrigation. To adapt irrigation to the reduced water needs, the FarmImpact project's application-based database will provide the farm managers with information about actual water use and future demand. The novel aspect of this research approach lies in the intelligent combination of networked microclimatic measurements, drone-based remote sensing, wind-field modeling, and ecophysiological modeling (Expert-N). The aim is to achieve a solid scientific basis for agricultural-economic assessment and optimized water management. The FarmImpact concept aims to use windbreak strips to grow water-efficient agricultural, wine, and fruit products based on new scientific methods. Against this backdrop, the development of a web-based software tool for predicting the actual need for irrigation in the adapted areas is a completely novel approach. In the space between two windbreak strips, there are typically zones with different reductions in wind speeds and evapotranspiration rates. According to Dr. Veste, by integrating current weather forecasts, measurement data from the soil moisture sensors installed in the zones, and the results of microclimatic ecophysiological modeling, the tool can accurately predict the actual irrigation needs for a specific farm and directly link them to controllable irrigation systems where appropriate.

Sustainable water and land use

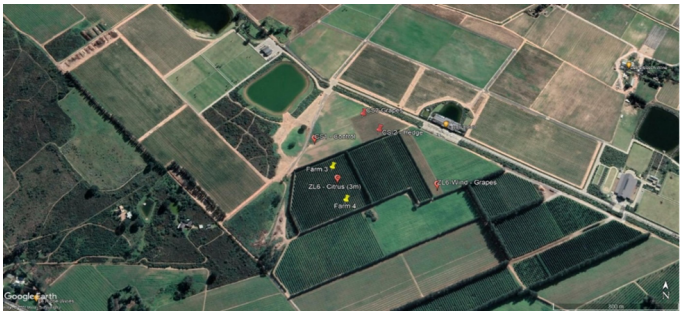
FarmImpact partners are working to develop practical recommendations for regional agriculture based on many years of field measurements. With the help of the water demand

analysis and an optimized concept of wind protection hedges, the agriculture industry can use water resources more efficiently and adapt production to the future challenges posed by climate change.

For more information, visit the FarmImpact project website.

Vineyard

Citrus orchard



The layout of the station on the farm

View online at: www.campbellsci.com/south-africa-sustainable-solutions-farms

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