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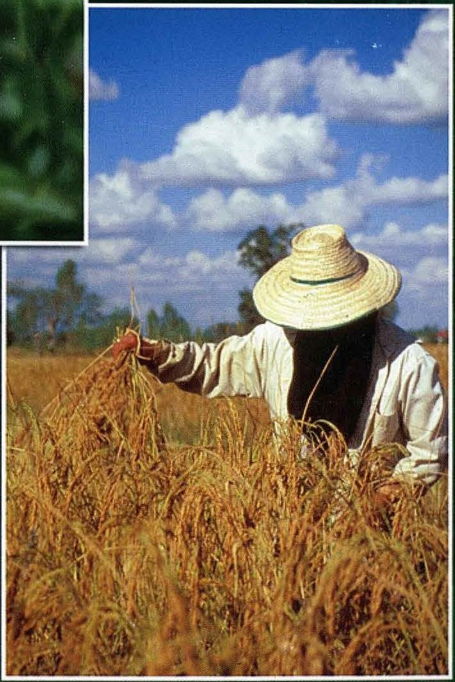
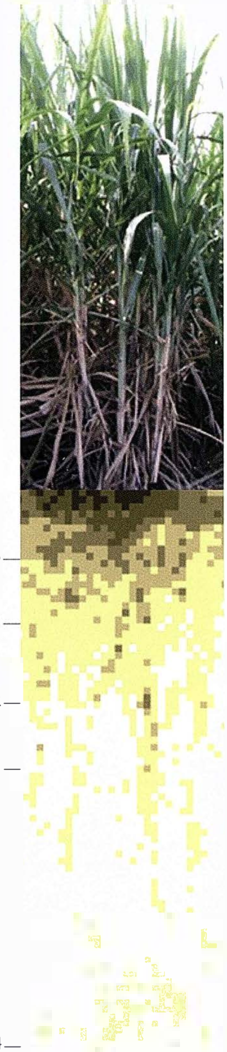


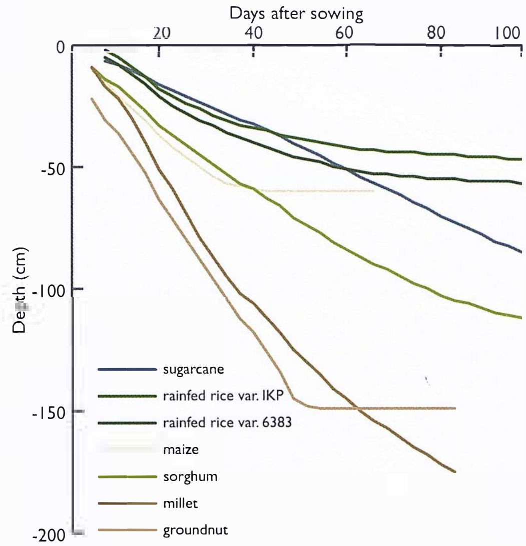
Agronomy
Crops and cropping systems

Number 12

The root system: *in situ* knowledge enables optimization of crop functioning



Root systems have many functions, e.g. supplying plants with water and nutrients, maintaining the soil structure and its organic status, and reducing erosion risks. The rhizosphere is also a unique ecological niche with intense soil biological activity. These features are especially important under tropical poor fragile soil conditions. The conventional measuring method whereby slices of soil under crops are extracted provides access to the root front and root biomass. However, in addition to its complexity, this method does not provide access to the spatial distribution of roots in the soil.



The developed method is based on mapping root intersections in a soil profile (RID). This facilitates study of the root distribution in the soil but does not indicate the root length per unit volume of soil (RLD), despite the fact that this variable is used to analyse and model the crop water supply. Validated semi-empirical models were developed for maize, rainfed rice, sorghum and sugarcane to estimate RLD from RID. A specific software package was also developed to manage the many spatial data required for the method. It enables users to understand why cropping practices, such as tillage, fertilization and irrigation, have spatiotemporally variable effects. These field study methods and their results should help in designing and evaluating sustainable cropping systems in dry, nutrient- and carbon-poor environments. Studies are under way to link biomass and root lengths so as to be able to estimate biomass and its distribution via the root intersection mapping method.

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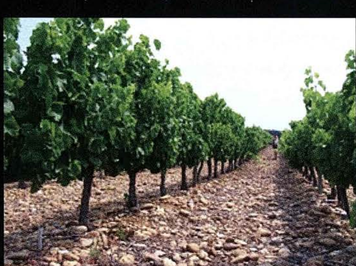
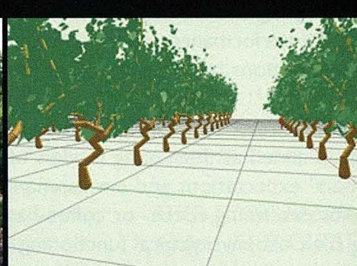
Development of tools for analyzing grapevine canopy functioning





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The crop canopy is a site of mass and energy exchanges between the plant and atmosphere. There is high microclimatic heterogeneity in this complex environment. Many studies have shown that the grapevine canopy structure affects the yield via its effects on light interception, photosynthesis and transpiration. It also affects grape ripening and the harvested grape quality by modulating the fruit lighting and temperature conditions. In a given environment, adapting this structure to meet different wine production objectives (red wine for aging, low alcohol wine, grape must for fruit juice production, etc.) is a current major agricultural challenge.

The studies are based on 3D plant structure representation methods with the aim of developing analytical tools suitable for investigating the functioning of grapevine canopies. The TOPVINE model was developed for dynamic prediction of the formation of the leaf area and its response to water deficits in different grapevine cultivars. This leaf area is then distributed through a probabilistic description of the space explored by each branch and the position of leaves within the space. By this description, the canopy is viewed as an assembly of branches represented by 'leaf clouds'.

These tools were tested and compared with canopy functioning indicators that are currently used by industry professionals (e.g. the illuminated leaf area) in a range of different 'cultivar x cropping system' combinations representative of Côtes du Rhône vineyards. The results of these initial simulations highlighted the close interaction between the grapevine architecture and the cropping system in terms of the radiation balance, which was not discernible with the indicators used to date.

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◀ Left - *Reconstruction of a vineyard canopy structure with the TOPVINE model (cv Grenache, espalier training).*

Right - *3D model of the canopy structure.*