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From Intuition to Bioengineering, Plant Physiology has Blossomed over Past 25 Years

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**FROM INTUITION TO BIOENGINEERING,
PLANT PHYSIOLOGY HAS BLOSSOMED OVER PAST 25 YEARS**

DAYTON, Ohio — The progress in plant biology over the past quarter century that has led to bigger yields, improved varieties and designer genes would have been slower if scientists from three disciplines had not gathered in 1974 in Canada to pool their knowledge of plant anatomy, physiology and biophysics.

"Nobody knew much about how plants transported sugars, although there were many theories, and scientists in different disciplines weren't talking to each other," said Brother Don R. Geiger, S.M., plant physiologist and biology professor at the University of Dayton.

Geiger, who attended that first meeting and each of the four gatherings since then, will give the opening address and keynote address for this year's International Conference on Assimilate, Transport and Partitioning, to be held in Newcastle, Australia, from Aug. 15 to 20. Some 250 scientists and student scientists are expected to attend the conference, which is held every four years and focuses on how plants transport energy.

This year's meeting represents the 25th anniversary of that first scientific gathering to integrate the study of structure, physiology and molecular biology of plants. "Scientists tended to be more self-sufficient back then," Geiger remembered. "That 1974 conference was the beginning of greater teamwork."

Part of the impetus for the scientific inquiry was a growing recognition of worldwide hunger, said Geiger, a member of the Roman Catholic order of the Society of Mary. "Out of the first Earth Day in 1970 was born the notion of population and its consequences. Then there was a drought in the Sahel (a habitable stretch of land at the edge of the Saraha Desert), and it suddenly dawned on people that hunger and starvation were issues as the world's population continued to grow.

"The time was ripe. The needs were seen," he said. "In the back of people's minds was food. How do we get increased productivity?"

Scientists of the time had more questions than answers when looking at how plants could be made to produce more food. "We don't eat many leaves. We tend to eat fruit, roots and tubers," Geiger said. "We knew sugars and other carbon compounds had to be transported from leaves, where they were manufactured by photosynthesis, to those harvested parts of the plant, but we didn't know how. That was a critical issue."

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By the mid-1970s, Robert T. Giaquinta, a doctoral student at UD, had devised a laboratory method to show that the minute veins in the leaves loaded sugar, and this provided the internal pressure that transported it through "sieve" cells. "The plant would rapidly transport a sugar solution with the viscosity of Karo syrup through its system of veins. But if you cut the veins to examine them, all the pressure would dissipate and the sugar solution inside would just run out. For his dissertation, Bob learned how to freeze the tissues quickly, which kept the structure of the working veins from changing."

In the campus electron microscope laboratory, Giaquinta used alcohol to remove water from frozen plant tissue, replacing it with plastic, and looked at the structure in the conducting veins. Using another technique, radioactive sucrose was tracked as it moved through the plant, giving scientists more information about the inner workings of the sugar-carrying veins.

In such ways, researchers "kept nibbling away" at the mysteries of plant productivity. Today, "we know in great detail how it all works and we've even sequenced the main genes that are needed to drive sugar transport," Geiger said.

Although crop yield continued to be an issue, other concerns surfaced over the years, Geiger said. "By the 1990s, we were thinking about how to lessen farm inputs so that we could produce the same amount of food but with less fertilizer, herbicides, etc. The concept of low-input sustained agriculture was born in the 1995 Farm Bill."

Some issues don't change, however. "The population hit six billion in July. We better get pretty efficient if we want everyone in the world to eat even a basic diet, much less the way we eat here in the United States."

Geiger sees a place for what has become a controversial development in plant physiology — bioengineering — to help meet the challenges of the future.

A promising area is making plants less prone to injury by environmental stresses, he said. "Also, we have to learn to regulate how plants invest the products of photosynthesis. At harvest, it's standard that 20 to 40 percent of the plant will be usable for food. If we learn how genes regulate that, we can improve or maintain the numbers under temperature or drought stress. By controlling translocation, where the energy goes in the plant, we may be able to increase that percentage.

"Making changes by genetic modification need not be basically different from traditional plant breeding. It is more efficient."

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For media interviews, contact **Brother Don Geiger, S.M.**, at (937) 229-2509 or via e-mail at geiger@neelix.udayton.edu. Geiger will leave for Australia Aug. 12 and return to campus Aug. 22.