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# This Week's Citation Classic®

**Morse R N & Evans L T.** Design and development of CERES—an Australian phytotron. *J. Agr. Eng. Res.* 7:128-40, 1962.
[Engineering Section and Division of Plant Industry, Commonwealth Scientific & Industrial Research Organization, Highett and Canberra, Australia]

The biological and engineering design criteria used in the development of the Controlled Environment Research Laboratory (CERES) are discussed, and the phytotron building and several novel features of the plant growth cabinets, such as their daylength shutters and reverse cycle operation, are described. [The *SCI*® indicates that this paper has been cited in over 160 publications.]

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The first phytotron was conceived by Frits Went and built at the California Institute of Technology in 1949 as the Earhart Laboratory.[1] Five years later I was working as a postdoctoral fellow there when it was visited by Otto Frankel, who had decided that Australia also needed a national phytotron facility based in the CSIRO Division of Plant Industry in Canberra, of which he was chief. He enlisted Went's eloquent support for his proposal, recruited me as biologist, and called on the skills of Roger Morse and his colleagues for the engineering design aspects of the project.

Roger subsequently visited me at the Caltech phytotron, and we discussed in some detail the strengths and weaknesses of its design and of other approaches that might be taken. Several other second-generation phytotrons were being launched at that time, mostly with designs based closely on the Earhart Laboratory, but we saw many advantages in following the advice of the poet Gerard Manley Hopkins to "admire and do otherwise." The reasons are set out in our paper, but I should acknowledge that the design path we followed owed much to Walter Schwabe's setup at Rothamsted in England.

One of the advantages of the CERES design was that all the main components, especially the various cabinet types, could be thoroughly tested before the phytotron was built. In fact, this phase lasted several years, while the engineers tested various ways of meeting our specifications and forced us to clarify what we meant by them and whether they were really needed. At the same time we biologists had to find, by experiment, the answers to the engineers' requests for design criteria, such as the optimum speed and direction of air movement from our point of view—very different from theirs—or the importance for plant growth of reducing vibration.

This marriage of biology and engineering—which had elements of both partnership and warfare—led eventually to a thoroughly tested, reliable, and adaptable phytotron, the design of which was described in our paper. There were no teething problems after its opening in 1962, and it has been filled with a great variety of plants and experiments continuously since then.

Of those who have used CERES, about a quarter have come from this division, many more from other Australian research groups, and almost a quarter from overseas. CERES has thus been a truly national, indeed international, facility. More than 600 papers have been published on the research done in CERES—including two other *Citation Classics*[2,3]—and this research was reviewed recently.[4]

The reason why our paper has been cited frequently is simply that the authors of many of these papers found this to be the most appropriate way to describe the controlled environmental conditions used in their experiments. Its selection as a *Citation Classic* thus reflects the quality, durability, and adaptability of the engineering design by Roger and his colleagues.

The name CERES was not only an abbreviation of controlled environment research but also the name of the Roman goddess of agriculture, and, like her, our CERES has been both decorative and useful, as well as a fertile meeting ground for many disciplines.

1. **Went F W.** *The experimental control of plant growth.* Waltham: Chronica Botanica, 1957. 343 p. (Cited 230 times.)
2. **King R W, Wardlaw I F & Evans L T.** Effect of assimilate utilization on photosynthetic rate in wheat. *Planta* 77:261-76, 1967. (Cited 155 times.) [See also commentary in: *Contemporary classics in plant, animal, and environmental sciences.* Philadelphia: ISI Press, 1986. p. 48.]
3. **Wardlaw I F.** The control and pattern of movement of carbohydrates in plants. *Bot. Rev.* 34:79-105, 1968. (Cited 215 times.) [See also: **Wardlaw I F.** Citation Classic. *Current Contents/Agriculture, Biology & Environmental Sciences* 16(18):18, 6 May 1985.]
4. **Evans L T, Wardlaw I F & King R W.** Plants and environment: two decades of research at the Canberra phytotron. *Bot. Rev.* 51:203-72, 1985.