

## Carl N. Hodges (1937–2021)

Dr Carl Hodges, a pioneer in seawater agriculture passed away at the age of 84 years on 3 April 2021 at Phoenix, Arizona, USA. In his passing the world has lost a great scientist and crusader in the field of seawater farming. He conducted path-breaking work as the former Director of the Environmental Research Laboratory (ERL), University of Arizona, Tucson, and as the founding Chairman of Sea Water Farms – a global company.

Born in 1937 in a Texas farm, Hodges was the first person to graduate from his family. After obtaining his doctorate in atmospheric physics from the University of Arizona, Tucson, he started working on a novel solar desalination process. He quickly moved ahead and became the founder Director of ERL. At about the same time, work on solar desalination had started in India at the Central Salt and Marine Chemical Research Institute (CSMCRI), Bhavnagar, Gujarat, where I was working as a trainee from the Indian Institute of Technology, Bombay, under the guidance of R. L. Datta. We started corresponding with Hodges and he would send us several detailed reports about his work. He visited CSMCRI in 1967 to attend India's first National Conference on Saline Water Desalination and impressed everyone with his vision and knowledge. At that time, India, under the leadership of Vikram Sarabhai, was preparing the blueprint of a nuclear-powered agro-industrial complex with large nuclear power desalination plants and everyone was excited about this new development.

Hodges' interest soon turned towards saline-water agriculture. He used to say, 'the history of the world would have been different if humans would have used seawater farming!' Next, his attention turned towards halophytes – the salt-tolerant plants. His research showed that changing the basic physiology of traditional plants from salt-sensitive to salt-tolerant would be difficult and it might be more feasible to domesticate the wild, salt-tolerant plants. After all, our modern crops started out as wild plants.

So, Hodges and his team of scientists began collecting several kinds of halophytes from around the world and screening them. There are nearly 3000 species of halophytes, including grasses, shrubs and trees such as mangroves. Halophytes like *Salicornia*, *Sueda* and *Atriplex* emerged as economically more feasible species for animal feed. *Salicornia bigelovii* was also found to be a good source of high-quality edible oil.



In 1972, I went to Arizona as a Visiting Scientist when a pilot plant was being set up at Sonora village in Mexico. Following this visit Hodges and I often discussed about setting up similar plants in the coastal areas of India. This was a big dream for me. Further, it was found that effluent saline water from shrimp farms could be an excellent feed for halophyte plantation. Large-scale seawater aqua agro farms were set up in Mexico and Eritrea.

In 2002, when I was the Vice Chancellor of Gujarat Agricultural University, Dantiwada, Gujarat we conferred an Honorary Doctorate on Carl Hodges and M. S. Swaminathan. Hodges, Swaminathan and I had several rounds of discussions for developing seawater agro-aqua farms along the Indian coastline and some experimental farms were started at Bhavnagar, Navsari and Kutch in Gujarat and Kalpakam in Tamil Nadu. The ERL team and later Sea Water Farms prepared a project

proposal for an integrated aqua–agro complex with the following components:

- (a) Aqua farm consisting of shrimp and other high-value fishes.
- (b) Coastal halophyte plantation.

After several rounds of discussions and visits, a consortium consisting of Sapphire – USA (Sea Water Farms), GSFC Science Foundation, M. S. Swaminathan Research Foundation, Chennai, and Gujarat Agricultural University was formed to work together for the aqua–agro complex, including seawater agriculture. A typical aqua–agro complex would have seawater as the main feed, fish farm (mainly shrimp), the effluent from which would go to the *Salicornia* plantation, which would be used for animal feed as well as producing oilseeds. There is good profitability in shrimp production and when effluent from the pond is used to feed the halophyte farms, there are several additional advantages. Although aqua–agro complexes from Sea Water Farms came up in Mexico and Eritrea, our dream for India is yet to be realized. So far only a few small units/demonstration models have come up. Hodges was restless and enthusiastic. He was among the rarest of scientists who considered that there is no need to believe that 'what was not possible yesterday cannot be possible tomorrow'. His wife Beth carries on his work at the Sea Water Foundation. Soon after his death she wrote that at the time of his demise Hodges was ceased with the water problems of Gujarat and Arizona and how they could be addressed.

Carl Hodges leaves behind a great legacy and many friends and admirers all over the world whom he would keep inspiring. To someone like me, who has known him since 1966, Hodges was an inspiring friend and an ever encouraging explorer.

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