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DESIGNATED AREAS HIGHER 50¢

COLUMN ONE

Letting the sea cultivate the land

Scientist Carl Hodges thinks big: Why not harness rising oceans to grow a desert food crop that could also one day overtake oil as a fuel?



Carl Hodges walks along a berm on a research plot where he grows salicornia and experiments with different planting and harvesting techniques. Hodges and his crew have flooded the plots with saltwater from the nearby Sea of Cortez.

Brian Vander Brug / Los Angeles Times

By Marla Dickerson, Los Angeles Times Staff Writer
July 10, 2008 *Tastiota, Mexico*

Carl Hodges is growing salicornia, a crop nourished by ocean water that holds the potential to provide food and fuel to millions.

A few miles inland from the Sea of Cortez, amid cracked earth and mesquite and sun-bleached cactus, neat rows of emerald plants are sprouting from the desert floor. The crop is salicornia. It is nourished by seawater flowing from a man-made canal. And if you believe the American who is farming it, this incongruous swath of green has the potential to feed the world, fuel our vehicles and slow global warming.

He is Carl Hodges, a Tucson-based atmospheric physicist who has spent most of his 71 years figuring out how humans can feed themselves in places where good soil and fresh water are in short supply.

The founding director of the University of Arizona's highly regarded Environmental Research Lab, his work has attracted an eclectic band of admirers. They include heads of state, corporate chieftains and Hollywood stars, among them Martin Sheen and the late Marlon Brando.



Hodges' knack for making things grow in odd environments has been on display at the Land Pavilion in the Epcot theme park at Walt Disney World in Florida and the Biosphere 2 project in Arizona.

Here in the northern Mexican state of Sonora, he's thinking much bigger.

The Earth's ice sheets are melting fast. Scientists predict that rising seas could swallow some low-lying areas, displacing millions of people.

Hodges sees opportunity. Why not divert the flow inland to create wealth and jobs instead of catastrophe?

He wants to channel the ocean into man-made "rivers" to nourish commercial aquaculture operations, mangrove forests and crops that produce food and fuel. This greening of desert coastlines, he said, could add millions of acres of productive farmland and sequester vast quantities of carbon dioxide, the primary culprit in global warming. Hodges contends that it could also neutralize sea-level rise, in part by using exhausted freshwater aquifers as gigantic natural storage tanks for ocean water.

Analyzing recent projections of ice melt occurring in the Antarctic and Greenland, Hodges calculates that diverting the equivalent of three Mississippi Rivers inland would do the trick. He figures that would require 50 good-sized seawater farms that could be built within a decade if the world gets cracking.



Carl Hodges holds a salicornia plant, a saltwater-tolerant species that he hopes will eventually be used to provide food and biofuel for millions of people in places where good soil and fresh water are in short supply.

"The only way we can stop [sea-level rise] is if people believe we can," said Hodges, whose outsize intellect is exceeded only by his self-assurance. "This is the big idea" that humanity has been waiting for, he believes.

With his trademark floppy hat, an iPhone wired perpetually to his head and a propensity to assign environmental reading homework to complete strangers, Hodges might be dismissed by some as an eccentric who has spent too much time in the Mexican sun.

"When I first met Carl, I thought he was a philosopher," said actor Sheen, a longtime friend.

Still, experts including Dennis Bushnell, chief scientist at NASA's Langley Research Center, say seawater agriculture could prove to be an important weapon in the fight against climate change.

Hodges has already built such a farm in Africa. Political upheaval there shut much of it down in 2003. That's why he's determined to construct a showcase project in North America to demonstrate what's possible.

All he needs now is \$35 million. That's where salicornia comes in.



A so-called halophyte, or salt-loving plant, the briny succulent thrives in hellish heat and pitiful soil on little more than a regular dousing of ocean water. Several countries are experimenting with salicornia and other saltwater-tolerant species as sources of food. Known in some restaurants as sea asparagus, salicornia can be eaten fresh or steamed, squeezed into cooking oil or ground into high-protein meal.

Hodges, who now heads the nonprofit Seawater Foundation, plugged salicornia for years as the plant to help end world hunger. Do-gooders applauded. The private sector yawned.

Then oil prices exploded. Hodges saw his shot to lift his fleshy, leafless shrub from obscurity.

That's because salicornia has another nifty quality: It can be converted into biofuel. And, unlike grain-based ethanol, it doesn't need rain or prime farmland, and it doesn't distort global food markets. NASA has estimated that halophytes planted over an area the size of the Sahara Desert could supply more than 90% of the world's energy needs.

Last year, Hodges formed a for-profit company called Global Seawater Inc. to produce salicornia biofuel in liquid and solid versions. He lugs samples of it around in a suitcase like some environmental traveling salesman.

The enterprise recently planted 1,000 acres of salicornia here in rural Sonora, where Hodges has been doing preparatory research for decades. That crop will provide seed for a major venture planned 50 miles north in the coastal city of Bahia de Kino. Global Seawater is attempting to lease or buy 12,000 acres there for what it envisions will be the world's largest seawater farm.



Marco Quinones, a colleague of Carl Hodges, looks for newly germinated salicornia plants in the cracked earth on a research plot near Kino Bay in the northern Mexican state of Sonora.

The plan is to cut an ocean canal into the desert to nourish commercial ponds of shrimp and fish. Instead of dumping the effluent back into the ocean, the company would channel it further inland to fertilize fields of salicornia for biofuel. The seawater's next stop would be man-made wetlands. These mangrove forests could be "sold" to polluters to meet emissions cuts mandated by the Kyoto Protocol on climate change.

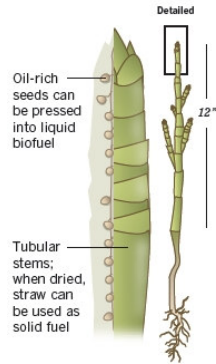
"Nothing is wasted," Hodges said.

The future's fuel?

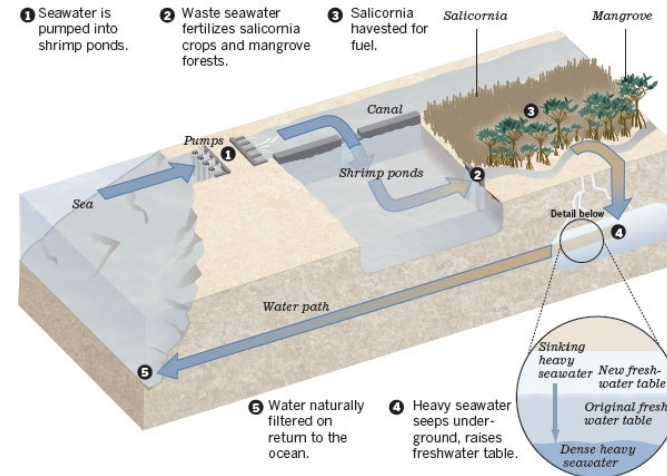
An Arizona company wants to use a saltwater-tolerant plant called salicornia to green coastal deserts and produce biofuel. It's planning a seawater farm in Mexico combining aquaculture, agriculture and forestry. But some environmentalists are skeptical.

The crop

Succulent annual herb; grows around salt marshes.



The process



The Kino Bay plan



Gallons of biofuel per acre per year

Salicornia	143
Soybeans	48

Sources: Seawater Foundation, ESRI, GoogleEarth, Times research

LUCIA PARKER Los Angeles Times

Global Seawater already has a small refinery to process salicornia oil into biodiesel fuel, which Hodges believes can be produced for at least one-third less than the current market price of crude oil. Leftover plant material would be converted into solid biofuel "logs" that he said burned cleaner than coal or wood.



Figure 1 A shrine graces the entrance to Don Oscar Nenninger's home on the Sea of Cortez in Sonora, Mexico. Nenninger, a shrimp farmer, is working with Carl Hodges to use effluent from his aquaculture operations to irrigate Hodges' salicornia fields.

NASA is interested in testing fuel from Hodges' halophyte. So are cement makers and other heavy industries. Retired executives from some major corporations are so encouraged by the potential that they are helping Global Seawater raise capital and focus on generating returns for investors.

Fernando Canales Clariond, former Mexican secretary of the economy and member of one of the nation's most powerful industrial families, recently joined the board. "The world doesn't move because of idealism," he said. "It moves because of economic incentives."

Fellow board member Anthony Simon, former president of marketing for Unilever Bestfoods, put it more bluntly. "Carl is a wonderful scientist," he said of Hodges. But he "is a lousy businessman."

Hodges has sold assets and maxed out credit cards over the years to keep his seawater dreams afloat. But it's not for the prospect of a big payday. A lifetime of studying the Earth's ecosystems has convinced him that the planet is in peril. He's determined to help get things back in balance.

Driving through the sun-scorched Sonora countryside, he pointed to abandoned grain silos and crumbling concrete irrigation channels, tombstones of failed efforts at conventional farming.



Shrimp farms in Sonora, Mexico. Carl Hodges wants to use effluent from such farms to irrigate fields of salicornia.

"It's a dust bowl," Hodges said. "We're going to making it bloom again . . . with a new kind of agriculture."

Some environmentalists are dubious. Wheat and cotton flourished here until farmers pumped aquifers nearly dry. Shrimp aquaculture operations have fouled the Sea of Cortez with waste.

Channeling millions of gallons of seawater inland could have similar unintended consequences for fragile deserts, said biologist Exequiel Ezcurra, former head of Mexico's National Ecology Institute. "We have had catastrophes in the past, so we have reason to be concerned," he said.

Hodges says his project has met all environmental requirements posed by Mexico. The biggest catastrophe, he said, would be to do nothing in the face of climate change.

"My father once told me, 'Carl, there is a special place in hell reserved for fence sitters.' "

The son of a horse trainer, Hodges grew up around racetracks. His dad once traded their Phoenix home for some thoroughbreds, moving the family briefly into a shed.



A stomach for risk-taking landed the young scientist in the top spot at the Environmental Research Lab in 1967 at the age of 30. There he decided that farming must be adapted to utilize saltwater, which accounts for 97% of the world's water supply.

His team's work on shrimp cultivation fueled the explosion in Mexico's aquaculture industry. The leader of Abu Dhabi sent his

lab \$3.6 million on a handshake to build a saltwater greenhouse system for growing vegetables in that arid emirate. Brando took a shine to Hodges after meeting him at an environmental gathering in the late 1970s. The reclusive star hosted the wonky scientist several times at his private island retreat of Tetiaroa in the South Pacific, an area especially vulnerable to sea-level rise.

"Marlon understood global warming," Hodges said. "He thought we were running out of time."

Hodges' model for the Mexico project is a seawater farm he designed for the government of Eritrea, an impoverished, bone-dry East African nation perched on the Red Sea. Opened in 1999, the farm consisted of ocean-fed ponds of shrimp and fish, whose waste was used to irrigate 250 acres of salicornia that the Eritreans converted into animal feed. A 150-acre mangrove wetland provided habitat for wildlife.

Political upheaval crippled the operation. But at its peak the farm generated hundreds of jobs and turned famine-prone Eritrea into a modest exporter of shrimp. Video footage of the endeavor shows a lush oasis of green in the desert.

"It was a miracle," said Tekie Teclemariam Anday, an Eritrean marine biologist who now works with Hodges in Mexico. "People viewed him like a messiah."

Whether Hodges' Big Idea wins a wider group of converts remains to be seen.

NASA's Bushnell says seawater agriculture has enormous potential. He praised Hodges' science as "superb." Still, he said algae might ultimately prove to be the best plant-based biofuel because it can produce much more fuel per acre.

Hodges is "a pioneer," Bushnell said. "But first-movers generally aren't the successful ones at the end."

Hodges contends that all manner of renewables are needed to wean the planet from its oil addiction. Still, his talk of stopping sea-level rise and reinventing agriculture is so audacious that some of his own backers have cautioned him to tone it down.

But longtime friend Sheen says Hodges isn't likely to. "We have to be outrageous in our efforts to solve" climate change, the actor said. "Carl is on a mission to save the world."