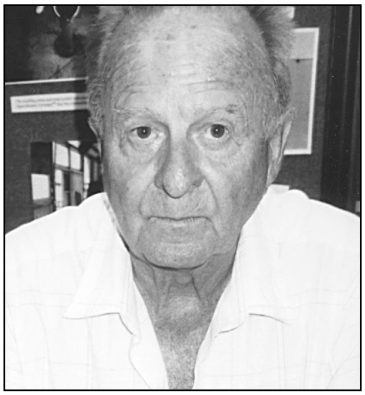
New Vistas in Bioremediation

Ancient Bacteria Eat Oil, Strengthen Plants

Carl Oppenheimer, Ph.D.



After receiving several degrees, including a Ph.D. in marine microbiology, Carl Oppenheimer did research for the Pan American Petroleum Corporation and taught in Oslo, Naples and Miami. He has served on presidential advisory panels and chaired a panel for NATO, among many other activities, and authored dozens of scientific articles. In 1980 he accepted a position with the University of Texas at Austin as professor emeritus of marine microbiology, also researching and lecturing at the university's Marine Science Institute in Port Aransas until his retirement in 1992. Dr. Oppenheimer is still a very busy man, however, traveling around the world to clean up environmental accidents, especially oil spills — and therein lies his claim to fame among Acres U.S.A. *readers, for Oppenheimer employs the assistance of some amazing microorganisms in his work. They are called* archaeobacteria, *a team of ancient RNA-based microbes that Oppenheimer has learned how to harness and use — they literally eat up hydrocarbons and other toxins, leaving nutritious fatty acids in their wake, and they also work as soil-life superchargers, recycling trace minerals and breaking down silicates for plant use. Also present for this interview was Guy McGowen, who distributes Oppenheimer's archaeobacteria mix in the United States under the trade name Biozome. To Dr. Oppenheimer's scientific expertise, he adds some of the experiences reported by famers in the field using this new technology.*

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ACRES U.S.A. What is your background?

OPPENHEIMER. I grew up in Los Angeles, a big city. I went to university in southern California, USC, UCLA, Redlands University, and I did my doctoral work at Scripps Institute of Oceanography, which was in LaHoya, although the degree came from UCLA.

ACRES U.S.A. How did you get interested in microbiology?

OPPENHEIMER. When I was a high school student I got interested in the field, and then when I went to Pasadena Junior College, I was a technologist for the Department of Bacteriology. That started it all off.

ACRES U.S.A. Your claim to recent fame is the ability to propogate microorganisms that can dine on hydrocarbons. How did you find those — or did you develop them?

OPPENHEIMER. My professor for my doctorate was Claude ZoBell, and he was sort of the father of hydrocarbon microbiology. I got my degree under him working under American Petroleum Institute project 43A, which was studying the origin of oil. Although my general field was microbial ecology, I always was fascinated by petroleum microorganmisms.

ACRES U.S.A. First of all, how is oil formed?

OPPENHEIMER. According to the recent experts, oil is formed from ancient marine deposits of the remains of algae and plankton, but it's incorporated in the sediment, which becomes anaerobic, and it is slowly converted from organic mate-

rial to hydrocarbons by losing its oxygen and nitrogen and other compounds.

ACRES U.S.A. Of course in our day we have *Exxon Valdese* and other ships spilling vast amounts of oil on the oceans. This is what we're interested in — how do you clean up that stuff?

OPPENHEIMER. Very difficult to clean it up in an active sea. I just got a recent report from Alaska indicating that maybe oil was still there and still toxic along the shore of Prince Albert Sound. But more interesting is that in one year, the oil introduced into the waters of the United States is greater in amount than that of the *Valdese* accident.

ACRES U.S.A. From different spills?

OPPENHEIMER. Just from the accumulation of drips on the street from automobiles, people disposing of oil in lakes, two-cycle gasoline engines for boats — all release oil. So there's a constant input of oil from various sources into the environment, and in one year it's more in volume than that introduced by the *Valdese,* which was the largest such marine accident at that time.

ACRES U.S.A. Let's go back to these microorganisms — did you find them, are they the same kind we'd have in the soil system in agriculture?

OPPENHEIMER. They're natural. If oil wasn't naturally biodegraded, it would accumulate — we wouldn't have to dig for it. But as I said, the amount of the *Valdese* spill is released in the United States every year and has to go somehwere, so there are natural microorganisms that break down the oil. My job was to harness them, just like a team of horses. Oil is composed of 300,000 different molecules and millions of isomers, so one microorganism alone doesn't do the work, that's the whole key, and what I've done is to assemble a team of microorganisms that will break down not only hydrocarbons, but also chlorinated hydrocarbons like DDT and dieldrin and chlordane and sewage, all types of organic materials.

ACRES U.S.A. Where did you find these organisms?

OPPENHEIMER. All over the world.

ACRES U.S.A. Do you propagate them, is that the idea?

OPPENHEIMER. Yes, we grow them right here. Right now we're shipping 50 tons to Japan.

ACRES U.S.A. Is that in a granular form?

OPPENHEIMER. It's in dormant, powder form.

"What I've done is to assemble a team of microorganisms that will break down not only hydrocarbons, but also chlorinated hydrocarbons like DDT and dieldrin and chlordane and sewage, all types of organic materials."

ACRES U.S.A. What were your experiences in cleaning up oil slicks?

OPPENHEIMER. I've cleaned them up all over the world — you can spray it over the surface of the water or mix it in with soil. We have groups working in Japan, Canada, and Mexico, South America, South Africa, Italy, all over the United States. We're responsible for cleaning a very large number of oil spills.

ACRES U.S.A. Did you work at that big spill they had off of Spain a while back?

OPPENHEIMER. No, we went to Spain and offered to help them, but that was too highly political. The problem with combatting big oil spills is that nobody wants to be responsible — the insurance companies don't want to pay for it, so it becomes highly political. We could have cleaned the Spanish slick. We did the research, we went to Spain and showed them how it worked, but they didn't use it, they just left the spill.

ACRES U.S.A. Is that what happened with the *Valdese?*

OPPENHEIMER. Yes, they couldn't clean it all up by mechanical means, so there's still a lot of oil left there on the rocks and crevices.

ACRES U.S.A. They haven't even tried to inoculate the situation with these microorganisms?

OPPENHEIMER. The EPA is not very favorable toward using microorganisms for some reason, so they did not use them with the *Valdese,* but they spent $50 million to clean it up — the State of Alaska almost went bankrupt when that happened.

ACRES U.S.A. What did they do to clean it up?

OPPENHEIMER. They sent teams of people out with sponges and absorbents.

ACRES U.S.A. That's really doing it the hard way!

OPPENHEIMER. Yes, they steamed some of it off, vacuumed the ocean, things like that.

ACRES U.S.A. Our primary interest, of course, in this whole technology is — what can it do for the soil system for the farmer?

OPPENHEIMER. By working synergistically with soil minerals and other elements, it can do everything that's needed — I've been studying the minerology of plants and animals for 30 or 40 years. I have a very large collection in my library of reports. Almost all of the periodic table is found in living systems, but we only know the importance of a very few — about 32 minerals have been recognized now to be cofactors in enzyme activity.

ACRES U.S.A. But as soon as somebody learns how to propagate and market them, then they'd become "essential," wouldn't they?

OPPENHEIMER. They're already available! When the sea was formed, it was formed by the condensation of water vapor, which then eroded the material for soil, and so the sea has been salty like it is now almost since it was formed. So the elements are all already present, that's

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why people who live along the shore and eat a lot of seafood and breathe sea air are more healthy than people inland.

ACRES U.S.A. In row crop production, what would be the approach?

OPPENHEIMER. The literature is not very rich in trace element analysis of soils. If you send a soil sample to, say, Texas A&M, you'll get back the main ingredients — sulfur, nitrogen, phosphorus, potassium, maybe some sodium, but none of the trace elements, and it's the trace elements that are important in restoring some of these depleted soils. The farmer will "export" the trace elements in the form of fruits and grains, etc., and then replace it with chemical fertilizer. Even most humus does not have the proper balance of trace elements. There will have to be, I think, probably 20 years of research before we know the actual balance of trace elements in nutrition. In the meantime all we can do is take information from the literature, and say OK, if these elements are *found* in corn, for example, then they must be *necessary.*

ACRES U.S.A. You'd have to have a trace-mineral key to all the enzymes so you won't be missing a bunch of enzymes to protect that plant from bacterial or fungal or insect attack.

OPPENHEIMER. Right. A healthy plant will be a resistant plant. But because of poor soil practices, plants are forced to grow by artificial supplements, just like chickens are, and they're not healthy. When a disease comes along, it's susceptible, so then the scientists immediately try to combat the disease. They forget the basic part of the problem, and they try to solve the results of the problem. This is partly a problem of funding. Most of the scientists get their money from the federal government or some big industry, but if you wanted about 20 grand to study the trace elements needed for corn, you probably couldn't get the money to do it. No scientist at the university has — the universities do not supply money to scientists, they have to get their own money for their research, in general. Some universities have foundations and so on that do supply research funds.

ACRES U.S.A. In using these special strains that you've developed and gathered together — would you use them in the soil or on the leaf or a combination thereof?

OPPENHEIMER. For crops, you'd use it in soil. It's not a fertilizer — the microorganisms help recycle the indigenous minerals. Of course, if the minerals are not there, they can't recycle them.

ACRES U.S.A. You have to give the microorganisms something to eat if you put them into the soil.

OPPENHEIMER. You have to give them something to react on, yes. But one of the most important things we found out was that our microorganisms do dissolve silicates, and silicates are necessary for almost all plants for their structure.

ACRES U.S.A. And they dissolve the hydrocarbons.

OPPENHEIMER. They *decompose* the hydrocarbons.

"Almost all of the periodic table is found in living systems, but we only know the importance of a very few — about 32 minerals have been recognized now to be cofactors in enzyme activity."

ACRES U.S.A. What are the breakdown products?

OPPENHEIMER. Initially, they're fatty acid. The bacteria add to a hydrocarbon molecule — which is only hydrogen and carbon — they add two atoms of oxygen, which makes the hydrocarbon into a fatty acid, it's no longer a hydrocarbon. That's why the acid acts as an energy source for the same group of organisms or for other organisms, including earthworms and so on. Eventually that fatty acid is used as a carbon source and as an energy source. For example, we have a project in Venezuela for Lake Maracaibo, which is heavily polluted by the oil fields on the lake. The soils around the lake are just saturated with oil. We have proposed that it be cleaned up and moved to the farmlands adjacent to the lake, which are not very rich, and our microorganisms and the bacteria will then use the oil to produce fatty acids, which are soil conditioners, energy for other organisms, and allow some nitrogen fixation to take place and increase the soil physical properties.

ACRES U.S.A. Then the oil contamination could be turned around into becoming a fertility element for crop production?

OPPENHEIMER. That's right. That's the basis of our whole company. We convert pollutants into resources.

ACRES U.S.A. How long have you been doing this?

OPPENHEIMER. About 14 years. The company was started in 1990.

ACRES U.S.A. You've taken this not just to the United States, but internationally. Where do you get the best reception?

OPPENHEIMER. Internationally. We don't have any activities in Texas except for Guy's plants.

ACRES U.S.A. Guy, what are you doing with the soil?

GUY McGOWEN. We're using the bacteria and trying to encourage people to compost. When they compost, it breaks down into fatty acids and does condition their soils, so a lot of people do not go out and use a lot of liquid fertilizers and things like that. As their crop fertility begins to increase, the plants become disease resistant, and most have the experience that even if there's aphids on the leaves, they can't break the structure of the leaf because it's just too thick and hardy for them. So the natural actions of the plants as they're growing stronger allows them not to use pesticides instead of just not *wanting* to use them. They actually don't need to, and that's the long-term effect of what we're trying to do, but here in Texas, if it's not oil-based, they don't want to hear it! So I'm having more luck overseas myself.

ACRES U.S.A. You use this as a compost starter?

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McGOWEN. Yes, it's probably the best compost starter on the market. Because the bacteria are RNA-based, they're extremely active, and they outcompete the other bacteria for the food sources, and they take over the matrix. Their existing and working temperatures are in the range of 185 F, as opposed to the regular bacteria, which die out at 145. This allows for hotter, faster-acting type compost.

ACRES U.S.A. You supply this in a powder form. I presume you add some water, spray it on the compost pile, and it starts to work?

McGOWEN. Yes, that's right.

ACRES U.S.A. If you didn't use these microorganisms as a compost starter, what would you do — just put it on the soil?

McGOWEN. Yes, we put it on the soil, also, but farmers who have farm equipment have figured out many ways of using the Biozome, more than I could ever dream of. A lot of them are using it for the corn when they drill into the ground, they use their old Gandy box, which used to be used for pesticides — now they're using it for the Biozome and putting a fraction of the bacteria on the seeds individually. So it changes from 100 pounds per acre down to about 10 pounds per acre, making it economical for them to use.

ACRES U.S.A. So the seeds have got the wherewithal to come up anyway, and now they've got this additional kicker.

McGOWEN. That's right. The germination times — it's been our experience, for example, that corn seeds usually come up in 10-12 days. Once the bacteria has been introduced, moisture is added, and the seed propagates properly, when you drop the seed into the soil, it will come up in about 3-4 days. This is across the board for every single seed that goes into the ground. As long as nutrients are available to that seed, when it hits that soil, it just about triples the germination rate.

OPPENHEIMER. These bacteria are in a special group. I learned very early that the more effective ones were more primitive. So I collected from hot springs and volcanoes and salt-deposit areas, and they all fall into the class of *archaea,* a primitive group of microorganisms that is just now being recognized, but their biomass is supposed to be equivalent to all other biomass on the Earth's surface. They are very abundant, then, but they have not been studied except for a few exceptions. They consume methane as a carbon and energy source.

ACRES U.S.A. Do you find them mostly in the Tropics?

OPPENHEIMER. No, some of the first ones I found were in Norway underneath some of the old houses where they used fuel oil for heat. I found some others in Alaska that were at the old salmon canneries along the coast where they used oil for making the steam to process the cans. I've gotten them from the Antarctic, I've gotten them from the bottom of the ocean, many places. Wherever I go, I collect, in all adverse environments.

ACRES U.S.A. They like very hot temperatures, don't they?

OPPENHEIMER. They'll stand very high temperatures, and high salt conditions were used to help release oil from oil-bearing formations.

"Once the bacteria has been introduced, moisture is added, and the seed propagates, when you drop it into the soil, it will come up in about 3-4 days."

ACRES U.S.A. How many did you gather this way?

OPPENHEIMER. I don't know. You can't grow them individually. They only work as a team. They have no names, which makes it very difficult. Right now we're in a bind with Canada because they want me to name all of them. But they don't have names — they can't be grown individually . . .

ACRES U.S.A. Well, you'll have to dig out your Latin text and come up with names, won't you?

OPPENHEIMER. I thought about that the other day when I woke up early in the morning and said, "You know, that's a solution — I'll just name them!"

ACRES U.S.A. Nobody else has given them a name, you're entitled to do it if you discovered them.

OPPENHEIMER. I don't know how many names to give, though!

ACRES U.S.A. How do you propagate them? How do you grow them out and get the bulk you need?

OPPENHEIMER. Well, that is all intellectual property that we're very careful in protecting.

ACRES U.S.A. Can you say if you're doing it under very hot conditions or cold conditions, for example?

OPPENHEIMER. Both. In the winter it's cold and in the summer it's hot!

ACRES U.S.A. You've used it on corn?

OPPENHEIMER. Everything.

McGOWEN. I have a lot of experience with it in my own back yard, with every vegetable that everybody eats every day, and I grow my own spices, also. Since I've been going to the Acres Conference, I've been having a lot of contact with the farmers, and they've been using it on corn, milo, wheat, oats, things of that nature, and getting back to me with the results, which are always better than they had the year before.

ACRES U.S.A. What is the feedback exactly, say with sugarcane?

McGOWEN. There was a sugarcane test in China which wasn't really an official one — I just gave them a couple of bottles and let them try it last year in the month of May. When they came back, they didn't know exactly how to gauge things, because in China there's a lot of farmers who just go out and grow it and give it to the producers and say good luck! But the Sugarcane Association of Guangxi Province actually went out and used a Brix test. According to their Brix test readings, after using the bacteria and a lot of compostable materials as I had suggested, they had tripled the sugar in the cane. That was sufficient for them to invite me back, and I just returned last week from that visit. Now we're getting

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ready to do a soil fertility rebuilding project for the entire province. So they're testing it not only on sugarcane, but also on every crop that they're growing in their province.

ACRES U.S.A. In the Rio Grande Valley, they tell me they're growing about 65 different vegetables. What you're saying is that this could be used on any and all of them?

McGOWEN. That's correct.

ACRES U.S.A. Would it prevent nematodes, or things like carrots that are cracked?

McGOWEN. As Carl mentioned, there are a lot of things that scientists don't know as far as which element produces what type of effect in the plants. Generally speaking, all plants become thicker in their leaves and stems, and when you do a Brix test, it's always in the "excellent" range. Plus, when you bite into a tomato, it really tastes like a tomato — not a piece of cardboard!

ACRES U.S.A. What happens when the microorganisms run out of food and die out?

OPPENHEIMER. Imagine a dead whale on the beach. After the whale is gone, the microorganisms are gone. They've done their job. After about six months or so, the whale has been completely recycled.

ACRES U.S.A. How would you advise farmers or gardeners, then, who want to achieve healthier soils?

McGOWEN. Composting and trying to get people to compost is the first thing; also, trying to educate them as to the importance of the trace elements. That seems to be a difficult job both here and overseas. That's what we're trying to reintroduce into the soil as a foundation for establishing sustainable agriculture. Every pound that you take out of a garden in every single trace-element percentage has to be put back, because farming is not just farm it, then walk off and leave it — you want to have the same farmland be productive every year. So whatever you take out, you've got to put back, not just NPK. Somebody's got to start the ball rolling somehow, and since the universities have to ask for their money, there's usually strings attached. The scientists are doing their jobs, but you've got to ask the right questions before you find the right answers.

OPPENHEIMER. One of the key diseases today, I think, is deficiency, but there's not enough being done along those lines.

ACRES U.S.A. That's what Linus Pauling said, that all degenerative metabolic diseases can be traced to the abscence or a marked imbalance of some trace nutrient.

"I collected from hot springs and volcanoes and salt-deposit areas, and these bacteria all fall into the class of *archaea,* a primitive group of microorgan-isms that is just now being recognized, but their biomass is supposed to be equivalent to all other biomass on the Earth's surface."

OPPENHEIMER. When you consider all the research that's been done on animal food, say dog food — you can give a dog basically the same food for 15 years. The feed industry has it worked out pretty well, but humans have a mind of their own and have the ability to select what they want, whereas dogs have to eat what you feed them, so they have a captive diet. There's been a tremendous amount of research done on animal feeds that could be applied indirectly to soil fertility.

ACRES U.S.A. The old *Morrison's Feeds and Feeding* had all that in there, the diseases created by deficiencies, etc. They stopped doing that about 20 years ago or so, but back in the old editions, if you can find one, the information is there. Guy, what was your reception in China when you presented this particular preparation?

McGOWEN. When I first entered China in May of last year, it was at the height of the SARS virus scare. When we landed, there were only six people on our airplane, and in Beijing Airport there were very few people. So when they were checking everybody, they checked everything quite thoroughly, and I did have a biological statement and guarantees that this is not harmful. But since there were very few people there, and they saw "biological-something," they got very upset and pulled me out of line, put me in the inspection stations, and called for the guards with guns. It was scary. Then I showed them the paper, and of course they were not exactly scientifically minded, they just wadded the paper up and threw it in the basket. I thought, "OK, I'm in trouble." They called their supervisors and they all got their masks on and the guns came out and they started pointing them at me. After about five minutes of this, I'm starting to sweat a lot, scared for my life. I finally opened one of the bottles, stuck my finger in it and put it inside of my mouth and licked it. They looked at me, they pulled back the guns, started walking away, they just put the top back on and said, "Bye!" I went back just this past January, and as soon as I got in there, of course there was no longer a SARS scare going on, but I had the biological statement, and they called the captain over. Without even asking anybody, I just opened it in front of everybody, licked it. He smiled, stamped it "approved," and said, "Goodbye." So that's what it takes is actually tasting it in front of them to "ease the tension."

ACRES U.S.A. This is kind of a fine powder, almost a talcum powder. How would you put it in the row?

McGOWEN. Ordinarily, we just broadcast it out in a dry form for the smaller areas, because we have containers with little shaker tops for backyard gardens.

ACRES U.S.A. Kind of like a shalt shaker.

McGOWEN. Exactly. Farmers have used it in many different ways. They have things I've never heard of before, and I'm trying to record all of them. One man is using it with some sort of static electricity and having it stick to the seeds for oats as it goes through. Another is using molasses, and he mixes it in, lets it set

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overnight, makes a solution out of it, and then uses it on corn seed. There are some people who have large tanks with agitator systems — it is a bentonite clay base and it does need to be shaken up — and they are mixing it with grass seeds and broadcasting it out like a fireman's hose. But the one method that seems to work the best for everybody as far as machinery is concerned is using a Gandy box. It has a very refined metering device on it, we even get it down extremely small. It takes what is called a triple-shank, one has the seeds, dropping them down the tube, gravity-flow, another has the dried fertilizer and then the dried Biozome. They all drop down, three into one, as it drills, and of course the tiller tills it over at that point. They can do 10-12 rows on each side as they run the machinery down the rows. It makes it a very economical and fast broadcasting method.

ACRES U.S.A. Some are using molasses with it? So they'd have a readily available form of carbon to go right down with the plant.

McGOWEN. That's right.

OPPENHEIMER. More important, molasses does have trace minerals.

ACRES U.S.A. As opposed to refined sugar.

OPPENHEIMER. Right. Again, it depends on what was done in the field when the sugarcane, sugar beets, etc., was grown as to what the balance of trace elements are. There is a potential problem with using molasses, however, which is that it has a high osmotic pressure, and it can kill the microbes if it's concentrated. The same way with chemical fertilizers — if you put too much in a liquid solution with bacteria, it can kill the microbes.

ACRES U.S.A. What kind of a ratio would you want?

OPPENHEIMER. We have developed a special fertilizer with some of the common trace elements in it, and we use it at about the same weight as the microbes, so if you used a pound of microbes, you'd use a pound of fertilizer.

ACRES U.S.A. How much water would you use?

OPPENHEIMER. Depends on how you're going to apply it. It most cases, it's applied by pressure, so it's probably diluted 1 to 50. You can use a high-pressure sprayer — in fact, we use it to inject microorganisms into the soil.

ACRES U.S.A. Is this the future of agriculture? These kind of products?

OPPENHEIMER. I think it *has* to be the future, because our knowledge of basic elements as far as human nutrition is not well known. Evidence that most of the periodic table is found in living organisms in very small concentrations indicates that in order to replenish our soils, we're going to have to go in that direction.

"Farmers have been using it on corn, milo, wheat, oats, things of that nature, and getting back to me with the results, which are always better than they had the year before."

ACRES U.S.A. We've got our soils down to not just a half a percent of organic matter in the Rio Grande Valley, but an *eighth* of a percent in many cases. In other words, they're spoon-feeding the crop almost on a hydroponic basis. But this material would exempt them from some aspects of that particular approach, is that right?

OPPENHEIMER. Depends on whether the trace elements are in the soil. If they're not in the soil, this will not make trace elements.

ACRES U.S.A. You'll have to come up with some trace elements to go along with it.

OPPENHEIMER. The best industry research on trace elements that I know of was done by the citrus industry. A long time ago I worked with the citrus industry in converting chicken manure. The microorganisms used the ammonia present in the chicken litter, and we were using it now in the East to reduce the effects of the ammonia alkalinity. The concept was that most chicken fertilizers are harmful to plants because of the high ammonia, so if we treated the chicken manure with our microbes, it would remove the ammonia and it could be used for citrus, because the chickens do get trace elements in their feed. It could then be used for the sandy soils in Florida, which are easily washed of nutrients. But then they came up with foliar spraying, so now they spray the trace elements on the leaves, which take them up.

ACRES U.S.A. We've seen some Florida pasture producers spray ocean water on the pasture, not directly but diluted, probably 100 to 1, and remarkable recovery to the pasture.

OPPENHEIMER. The problem with that is that the trace elements are soon depleted again, so you have to do it again, and then you build up salt — because almost all of the minerals in seawater are sodium chloride.

ACRES U.S.A. So the big question is, what would be the salt buildup over a period of, say, 10 years or so?

OPPENHEIMER. You could calculate that, by altering the dilution of the seawater and the amount you put on per acre. It's easily determined. But that's the other thing — microorganisms seem to allow the plants to grow at a higher salinity. They can withstand higher salt concentrations.

ACRES U.S.A. Guy, what are you doing to market this?

McGOWEN. I have a website, I go to garden shows and conferences, and I'm working with the Chinese government, which actually called me and said, "Please come over, we need your help."

ACRES U.S.A. As it relates to pasture, what are your findings with Biozome?

McGOWEN. We've found that if there are available nutrients, the grasses become stronger, individual blades of grass are thicker, and the root systems are much deeper and more extended. When there's more roots, of course, there's more root uptake of nutrients. A grazier called me yesterday from Colorado to tell me it was helping his pastures grow better, and he noticed the leaves were growing

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stronger also, but because most of them had a very short root system, it was increasing the sugar amount in the weeds, which made them puff up and basically open up and die out, so he's getting a project together for the U.S. Forestry Department for weed elimination by using the Biozome, which increases the sugar mass, breaking it up and biodegrading it faster.

ACRES U.S.A. What I'm thinking of is what can we do to spray on the pasture to give cows nutritious grass?

McGOWEN. We are working on a project right now in Amarillo, Texas. A friend of mine from England is a scientist who's been out there working with the Biozome for the last two years, and he's increased the oat yield from 23 to 30 bushels per acre strictly by small tilling, adding the Biozome, and a lot of manures — as you know Amarillo's got a lot of free manure to spread around. Now they're trying it on larger acres on the Amarillo area, where they're using a low-till method with Italian grass because of better root systems that allow it to have a healthier crop and to hold the moisture. That's the key to the whole thing in the Amarillo area, holding the moisture in the soil. So we've got a proposal set up, and we're getting ready to start a soil fertility rebuilding project in the Amarillo area. We're starting out with 1,200 acres.

ACRES U.S.A. Is there anything you would like to add for our readers?

McGOWEN. From my point of view, this really is the future of agriculture, just in the practical application of turning garbage into food for the plants, which increases our plant/soil fertility, and a healthier plant makes healthier people. That's all I'm working from right now. I let the scientists do all the research. I just ask clients to prove to themselves with various tests which nutrients are being added to the soil and which ones are showing up in the plants after the season is over.

OPPENHEIMER. My feeling is that there should be some work started on gathering the information that we already had. Some years ago I was interested in a concept called Environmental Data Management, which would allow you to take all of the information, including old information like the *Morrison's Feeds and Feeding* that you mentioned earlier, and put it to use. For example, in the '50s, there was a publication that described the distribution of plants as related to certain minerals. Geologists can use this in order to look for deposits. There's a tremendous amount of information by the seed and feed industry. Some of that has been summarized a long time ago. There's also a very good book on plant nutrition that was published about 40 years ago from Russia. No one puts all of this together, everybody just sort of goes along their own way, but there's a tremendous amount of information available.

ACRES U.S.A. It just needs to be correlated.

OPPENHEIMER. Right, synthesized — but if I tried to get a grant to do that, they'd just laugh at me.

More information on Dr. Oppenheimer and Biozome is available from Guy McGowen, 4606 Copano Ct., Austin, Texas 78749, phone (512) 282-2087, website <www.biozome.com>.