Tape 1, Side A

Harold K. Steen (HKS): Don Marx interview, June 20, 2005, Tape 1.

Don, I just have on the outline, as you remember early years. The bio somewhere said you entered the United States at age three.

Don Marx (DM): No, six months.

HKS: Oh, six months?

DM: Yeah, I happened to be next to my mama when I was born and she just happened to be in British Columbia, Canada at the time so. My dad was a paper maker and he had an opportunity to, the Herty process was just discovered here in the South, how to make paper out of pine trees and all these paper mills began starting, building paper mills along the water, along the rivers here in the South. And he opened up a new mill in Orange, Texas right on the Sabine River and we moved there in 1936. Like I said, I was six months old. Stayed there til I was twelve and then we moved to Savannah where new paper mills were being built and he became machine tender at one of the paper mills in Port Wentworth right down the road here. During that interim period by the time I graduated from high school I went to eight different schools, moving from here to here to here to here. Nineteen fifty-two, 1953 I got a job with **{??? Veer 015}** Woodlands, which is now Continental Can, well it became Continental Can, and worked in their Swainsboro, Georgia district under Ted Earl, who was president of **{??? Veer 017}** Woodlands at the time. Giant of a man, he had to be six-eight, three hundred pounds and he took a liking to me. We just driving

trawler tractors, cutting fire breaks, killing hardwoods, and putting up gates and stuff like that for two summers, fighting fire. During the off-season of that during the regular year I lived on a farm and, of course, we were milking cows and feeding hogs. I had a pulpwood crew with I was fifteen, sixteen years old and on **{??? Veer 023}** Woodlands' property, which was adjacent to our property. Gave me free access to it. All they wanted to do is use or sell that timber at our paper mill. So old hand crosscut saws, no chainsaws back then. It was an interesting experience. This was when I really realized, you know, there was something about trees I liked.

Well, '54 I graduated from Benedictine Military School in Savannah and the previous year I joined the Marine Reserve when I was seventeen and I was at Marine summer camp at Camp Lejeune, North Carolina during the summer of '54 when I got a call. I was out in the field with the Marines and they said you got to get back to Savannah. They didn't tell me why. I thought damn, an emergency or something. Well, Ted Earl had put together the first scholarship to the Forestry School at the University of Georgia for me. I had to turn it down because I'd already joined the Marines. I had signed up to go in the Marine Corp, which I wanted to do, because I could not, at that time in my life I could not have made it as a freshman at the University of Georgia. Let's put it this way, I needed rather significant guidance during that period. So I went in the Corp. Best experience I ever had, all over the world, Saudi Arabia and the Persian Gulf. This was way before all this other stuff happened. Back in those days the news media didn't know what was going on. But Thailand, Sri Lanka, Cambodia, I was recon infantry, you know, incredible. Loved it. If I hadn't met her about three months before I got discharged I'd a made a career with the Corp. There's no question about it. But luckily she changed my life. She turned my life around. So I got discharged, right, and went to work at Union Camp in Savannah in a box

factory. Pete, I had a job making fantastic money. In fact, I did not make that same amount of money again until three years after my Ph.D., right?

HKS: I can believe that, yeah.

DM: But it was brain numbing. I could have trained a monkey to strip that excess cardboard off those boxes in five minutes better than I could do it. And I just got home one night, Selina was in nursing training up in Newburgh, New York, and I got on the phone and I said, will you marry me. Yeah. Come on home, we're getting married. I'm going to the University of Georgia. And we started at the University of Georgia January, 1958. We got married in '57, December of '57, and our whole life changed. First one in my family to ever go to the University. I mean just unheard of. Everybody was expected to be a paper maker. Well, what I decide to do to grow the trees and let them make paper out of it, okay. Well anyway, go to the University January of '58. We had absolutely no money. Had the GI Bill. Took four months to get your first check. I joined the Marine Reserve in Atlanta to get some money. I worked at a bouncer, pumped gas. Selina worked as an emergency room nurse at the hospital and for a surgeon, and until I finally, long story short, landed a job with the Forest Service basically starting out as a janitor, GS-3, lowest grade they could hire. Cleaned up the labs and everything else, in and around classes. Eventually within a year because of two key people, they allowed me to work a forty-hour week adjusted work week where I could work nights because we had kids coming like this by then, you know, good Catholic.

Mentors, unbelievable, the guys that for some reason liked what I was doing and I went to work, like I said, as a janitor, luckily that same lab under Dr. {??? **Braddus Leb 068**} Zak, Z-A-K, and Craig Bryan, to this day one of the best friends I ever had and still have, were starting the initial research on mycorrhizae in the Southeast. Again, we'd just learned how to spell it and we didn't know a heck of a lot about it other than the fact the type that occurred on pine trees produced mushrooms. And I was on the ground floor of that. I mean from the time they made an original discovery, a technique in that, I was the one that helped them put it together. I mean they said, Don, you do this, this, and this because we just discovered this. So I was on the ground floor of all that. Result was that I realized that the profession of forestry was not where I wanted to be. I wanted to be in research and I wanted it to be a micro biologically driven program with mycorrhizal fungi root disease. So I transferred from forestry into plant pathology under an incredible man, Dr. John Orr, who became president of North Georgia University later on. But this mycorrhizal thing was really strange, even among plant pathologists, because they were always dealing with disease causing fungi and here we are dealing with beneficial fungi. So this brought in a new segment to the plant path so I was doing all the lecturing on mycorrhizae. I'm an undergraduate and I'm lecturing to all the plant pathology courses on mycorrhizae, which you could do in about five minutes because there wasn't really a lot known about it. But it was exciting. It was very, very, was a lot of fun. Like I said, Craig Bryan and Zak and Dr. Mervin, Merv Reines, geneticist at the University of Georgia Forestry School, Guadalcanal Marine, right, the union between the Marines, you know, and he more or less advised me on what to do, many things. To this day, he's in his nineties, and he comes here, he and his wife, incredible individual. But with all that guidance and mentorship, whatever, setting the example, these guys were incredible. Got my B.S. in agriculture in '61 and immediately went off for a master's degree

working on mycorrhizae under Zak and head of the department, John Orr. Keep in mind, I have to stress this, we were one hundred percent of all the controlled research done with mycorrhizal fungi back then, it was first off only on the ecto-mycorrhizal, the type you have on pine and oak, spruce fir, very little done on the mycorrhizal type that occurs on eighty-five percent of all the other plants. But we were Forest Service and the major forest species for us was pine and oak, spruce fir. That's makes it the ecto- mycorrhizal association. That's the mushroom puffball producing fungi. And the only way that we could research it was to get about a two liter Erlenmeyer flask and put some vermiculite peat moss in the base of it, inside of it, and some mineral nutrients, autoclave it, sterilize it, and then have a pre germinated pine seed, aseptically germinated, right, planted in there, and hoped it would grow. And then after the seedling was established we would then inoculate it with a piece of auger mycelium, mycelium growing on auger plate next to the root system and hope that the fungus would grow and then form mycorrhizae on the roots and we'd have something to do research with. That was the nature of all the research back then.

HKS: A large part was just developing the technique?

DM: Exactly, everything was technique to begin with. In fact, my master's thesis was a technique where we were able to stabilize the Ph of the rooting substrate in those aseptic flasks by using peat moss. That's how it started. But that research that Zak and Craig Bryan did and Ed Haskill with the Forest Service at Beltsville Lab, John Palmer also with the Forest Service, they were in Maryland, gave us the names of some of the fungi, confirmed that this fungus, mushroom X, this **{??? amenota 120}**, this **{??? clatasite 101}**, whatever, is a real thing. It will

actually form ecto-mycorrhizae roots of these aseptically developed seedlings, which we never had before. We had no idea what they were. We knew they were out there but had no proof. Well, this was scientific proof that these guys do it.

Well, I got my master's in '62. During this time I'm working with Craig and Zak, I'm not working as a professional. We're colleagues in a sense. I'm still a grunt, you know, but we're a team. During that period of undergraduate and graduate school training we published, my name is on three publications with them, right? Liked that, it was kind of nice, because they were very generous. Well, about that time I finished up my master's, Zak was offered a transfer to Research Triangle, a new Forest Service lab in the Research Triangle Park where Andy Campbell, who was lab chief of Macon-Athens Lab at that time when I was an undergraduate and on my B.S. and master's degree. Andy Campbell, he's the discoverer of the cause of little leaf disease of short leaf and loblolly pine. He did that back in the '40s. Incredible gentleman, incredible leader, modest, in fact, he's so modest I don't think he'd even admit he got up in the morning. I mean he's just that kind of individual. Well, Zak turned the offer down to go to Research Triangle and he chose to go to Corvallis instead. Well, that left an opening for a mycorrhizal researcher at the Research Triangle Park. I said, can I'll take it because I'm going for a Ph.D. somewhere. I'd been accepted at the University of Wisconsin and wasn't too sure what I was going to do when I got up there, but they accepted me, gave me a scholarship in that. By this time we had three kids and there had to be an income. I had heard about Art Killman, Dr. Art Killman and Chuck Davie, Dr. Charles Davie, who did a lot of research in soils and nurseries at N.C. State. So I wrote them and said I'd like to come up and get a Ph.D. Well, they accepted me. And so long story short, '63 we went to Raleigh, moved in, found a place to rent in Cary and I'm working at the Research

Triangle. It was a brand new lab. We didn't have it equipped yet. I mean we're still designing benches and stuff like that for it, which was beautiful cutting the ground floor, you know. I want a sink right there and I want this here. And Andy Campbell, he'd been there for about a year. Chuck Hodges, Charles Hodges, who his fame is Annosus root rot. Did a tremendous amount of research with Annosus root rot here in the South and nursery research. He was the first Ph.D. at University of Georgia back in mid '50s, good friend, good scientist. He worked at the lab also. We designed the lab and got started. Ended up working a forty-hour work week, going to school fulltime, working around classes, working every night and weekends and stuff like that to get in my forty hours or sixty hours it boiled down to. The professors at N.C. State, Art Killman, Chuck Hodges, Chuck Davies, those guys were incredible. They just kept me between the ditches. Harry Powers was, at that time, involved with the station leadership and he was very, very supportive of this work. You have to realize that mycorrhizal research and the understanding of the significance of mycorrhizal fungi to forest trees and other plants by this time was almost like a fantasy. No one knew anything about it. And the more we learned, the more significant they appeared to become. It was more or less, hey, this is exciting stuff, you know. This is a new era and it was no more just dealing with pathogenic fungi and no longer dealing with muck beetles and stuff like that. We actually were looking for something that's beneficial. Can we work with it? So along the way I mean this became, well, a popular area of doing research. Well, I was fortunate. On my dissertation I worked with the fungi that Craig, Bryan, and Zak had discovered. I was their technician in Athens on how to grow them aseptically and synthesize the mycorrhizae. I chose as my dissertation is we've already been suspicious that an ecto-mycorrhizal association is resistant to disease development. So my dissertation over a three-year period was to study and test and to eventually discover that yes, ecto-mycorrhizal roots were

totally resistant to pathogenic attack by **{??? phytophra 187}**, the cause of little leaf disease, which Andy Campbell had discovered. Used all the fungi that Craig, Bryan, and Zak had discovered with the aseptic flask. I'm still using the aseptic flask. And long story short we found that they were resistant to pathogenic attack and they also many of them produce very strong antibiotics that were ideally located there in that war zone, if you will, to ward off the pathogen and I was fortunate enough to identify chemically one of the first ones, the first one, produced by a mycorrhizal fungus, because my location was right next to Research Triangle Park where all those incredible laboratories were, the Natural Products Lab, where they were just testing every conceivable plant part from all over the world to see if it contained any interesting chemicals. And they had this analytical stuff that I mean you could grind up a tree, put it in there, push a button, and out the end comes all the chemical analysis.

HKS: That's Taxol, right, for cancer?

DM: That's where it came from, exactly, the same thing. And we put our system through there and within four days I had a chemical identification of this antibiotic.

HKS: Did you work with the botany department or just strictly in the forestry school, I mean as a student?

DM: At N.C. State?

HKS: Yeah.

DM: Plant path, plant pathology department. I got my Ph.D. in plant pathology with a major in plant path, a minor in biochemistry and soils. I'll be perfectly honest. The only two courses in forestry I ever took was silviculture, a silvics, and forest path and I taught forest path at the University of Georgia. My junior and senior year I helped John Orr teach it and I taught the labs and then my senior year I actually taught the undergraduate forestry pathology component of forest tree protection for the forestry school, forestry students, which is kind of a, you could do that back in those days. I don't think you could do it now.

HKS: My plant pathology prof was in botany, a guy named Stuntz, and he was a fantastic teacher. I don't know if he ever published anything but he probably did a lot.

DM: Where was it, who, where?

HKS: University of Washington in the '50s.

DM: Stutes?

HKS: Stuntz, S-T-U-N-T-Z or something like that.

DM: You sure it wasn't S-T-U-T-Z?

HKS: No, I'm not sure. It could have been.

DM: Okay, because I know that name, yeah. He did some work with pythium root rot on nursery trees.

HKS: He was just a marvelous teacher. We all made jokes and had a party and always had a big bowl of slime with cherries and whipped cream on top and all this botany stuff. [Laughter]

DM: [Laughter] You have to admit that some of us were pretty weird when it come to things like that. You work with mushrooms? Yeah. So I became known as a mushroom guy. At least that was better than a toadstool guy, right? But while at N.C. State, like I said, the mycorrhizal theme, if you will, research on mycorrhiza, it was becoming more prevalent worldwide. The man who started it all was Dr. Elias Melin in Sweden at Uppsala back in the '20s and he's the one that actually designed this aseptic flask technique. And his research more or less was generating interest all over the world. Well, the first IUFRO congress on mycorrhizae was 1963 in Puerto Rico. And what we were there for, I was, they didn't have anybody else to invite I guess so they invited me to go with them, was Ed Haskill and his Beltsville Lab with the Forest Service said that we're going to prove that we can introduce pure cultures of ecto-mycorrhiza fungi into the tropics. Let me give you a little biological history here. There are no native ecto-mycorrhiza trees in the tropics at all, anywhere from the Tropic of Capricorn, the zones. They're all hardwood trees that form what call endo-mycorrhizae. We can talk about those a little bit later. But the fungi that form mushrooms or puffballs or form ecto-mycorrhizae were absent there because they don't have a host. See the ecto-mycorrhizal fungi, as are all mycorrhizal fungi, are obligate parasites. They cannot exist without the carbon they get from the plant host. They cannot

decompose organic matter independently and grow and survive. They must have the root association for their source of organic carbon.

HKS: So when the companies, U.S. companies, are planting lots of pine in Brazil on the Amazon?

DM: Because inoculate them. We showed them how to inoculate them. I'll get to that in a minute. Well, we went to Puerto Rico and it was, you have to realize and I'm not apologizing for the work that was done by us and others. You have to realize we were primarily mycologists, second, tree physiologists. At that time we did not fully appreciate or even understand or know that photosynthesis was a key component because the carbon that the plant was getting from the root system came from photosynthesis in the canopy and basically the tree would share the carbon, organic carbon with the fungus. The root system without that the fungus couldn't survive. The tree is the restaurant with these fungi. Well, we didn't fully understand that. Again, we were primarily mycologists, primarily interested in the fungus, the fungi, and the tree just happened to be part of it. Well, these trees, these little seedlings that were grown and inoculated almost as if they were an aseptic flask and then removed and transplanted in the field, were put in a rainforest canopy, maybe five percent sunlight, no photosynthesis because they were afraid of temperature effects and stuff like that and competition in these little seedlings this big were planted right next to monstrous trees. I mean at the time it looked brilliant. And we went down there and we spent five, six days looking to see if they could find them. We found I think five or ten percent. But this basically, the few trees that survived, believe it or not, grew very well. The ones that were not inoculated, they were dead within three days. So that was the beginning even

though it was not the world's best experiment for the first one it was. And it basically convinced everybody that yes, we can introduce pines into the tropics with pure culture inoculation of specific mycorrhizal fungi. Up until that time the forestry people running nurseries and wanted reforestation with pine, wanted a forestation program with pine in the tropic, would smuggle in forest soil from somewhere underneath pine trees here in the South or wherever and smuggle them into various places. In fact, I did a detective work, went backwards trying to track back where all this stuff came from when I started this work years later. Basically the first, a forester with the Tropical Research Institute in Puerto Rico was a pipe smoker, Prince Albert tobacco in a can. And he went to a conference in Maryland where they were talking about those plants have to have mycorrhizae somehow. This was back in the '30s. He went out and dumped his tobacco out and filled it up with soil, the humus from around some pine trees in Maryland, and brought it back to Rio Piedras in Puerto Rico and inoculated a small nursery area. The soil, humus, contained a variety of ecto-mycorrhizae fungi inherent on those trees and low and behold he formed abundant ecto- mycorrhizae. Those trees were out planting and grew like hell. Well, that started this forest soil inoculation using forest soil as an inoculum form to inoculate. This happened all over the world. Unfortunately it also introduced plant parasitic nematodes and pathogens, {??? **Pithims and Phitophus and** Rhizoctinias **and Fuzarians 326**} and some very serious plant parasitics. Nematode was also in that soil. So the idea, the whole concept became is what we need is a method to introduce specific fungi in a purified form, leave all the bad stuff behind, and tailor make, if you will, the trees in these locations. That eventually became fact but we're still twenty years away from that.

I left N.C. State after this Puerto Rican thing. In Puerto Rico I mean I'll give you the names of these people. Selina is working that up now. But all the names in mycorrhizae that were like gods to us, Eric **{??? Bjorkman 340}** from Sweden, who worked with Melin, you know, that damn guy could drink beer. **{??? Pesta Macola 343}** from Finland who was one of the leaders in that part of the world too. Ed Haskill, Beltsville, John Palmer from Beltsville Forest Service lab, Zak from Corvallis, **{??? Slankus 348}** from Canada, I mean these were all the apostles. And Jim Trappe—

HKS: I know Jim Trappe.

DM: I know you do. Well, Jim didn't have hair back then either and you can tell him I said that, but he was involved and I found out later that he wanted somebody he could boss around and that's why he invited me to come down. No, I'm joking about that. But I became the bus driver for all these world renowned scientists. I'm just a bus driver and listening to everything because I'm nothing but a graduate student. Well, I developed some damn great friendships with these people because they're all fantastic human beings and incredible scientists, inquisitive minds and risk takers, and especially Jim Trappe who became a very close friend after that and still is. But anyway after that meeting we more or less had, keep in mind that we didn't have emails or any of this other stuff back then. Communication was hand written letters or whatever. In fact, the Forest Service didn't have the DG then, you know, or anything. It was all telephone calls and U.S. postal mail, U.S. Postal Service. Anyway, we finished up at N.C. State in '66 and, like I said, the work that we did on mycorrhizae was so different. I mean no one else was working on it. That's the only reason that the recognitions came because it was the only ones being done. I

mean not as if there were five hundred people working on it and I was the one that did the wonderful stuff. There was nobody else doing the work except for Corvallis in Maryland and one or two other places. And we all worked as a team. We were sharing information back and forth weekly just about between Trappe and Zak in Oregon and Ed Haskill and John Palmer in Maryland and me and one or two others, world wide, I mean it was a [snaps fingers] everybody interacted together. As soon as I discovered something everybody knew it. Soon as they discovered, everybody else knew it. I mean it wasn't any of this closed stuff, you know, publish or perish or you're going to steal my information. But it was one of these strange things. I had seven job offers after I finished my Ph.D. at State. Penn State, one of the professors that I had, I didn't mention that I was also doing research with some university professors on **{??? Phytophra 396}** and pythium and we published eight papers on **{??? Phytophra of peas 397}** and stuff like this. Learned a great deal from these guys, wonderful people. And one of them took a job as a professor at Penn State. He said I want you at Penn State. I want you to just open this whole thing up for us in Pennsylvania. Well, I went up to Pennsylvania and interviewed for the job and it was the dead of winter. I said it's too damn cold up here for me. I mean almost didn't get there because of the blizzard on these small little planes they fly into that small airport. But anyway, Yale, they wanted a root biology center. I went up and interviewed and gave presentations. University of Wisconsin, Auburn, Florida, Australia, **{??? Adelite 418}**. One of the mycorrhizal researchers wanted me to come up and work with him in Australia. Well, by the time we finished up the Ph.D. we had five children and our last child, my last son, born prematurely with a major heart defect and I could not afford to go anywhere that did not have good insurance. And so whatever job I took I had to take insurance. Now keep in mind back in

those days a lot of insurance companies, if I went to Penn State, for example, took that job at Penn State, my son would be excluded from health insurance.

Tape 1, Side B

HKS: Okay, the Forest Service and its generosity.

DM: They said why don't you come back to Athens. Andy Campbell again was back in Athens by this time. He was a project leader for the soil borne organism project. He said come back and continue your mycorrhizal research here in Athens. Well, we had left behind so many friends in Athens it wasn't any problem. Yeah, we'll come back to Athens. So we went back. This time we're now professionals. We're no longer a lab cleaning technician, working with some fantastic people who eventually became a professional. Came back warmly received by everybody and just went back to work. Didn't miss a lick hardly from what we did at Research Triangle Park because a lot of the equipment that I developed at the Research Triangle Park I brought with me to Athens. There's one major issue what happened in Research Triangle Park that really basically opened up the world for us. Thank God for serendipity. This aseptic flask thing I was just telling you about, well, we had to grow these plants in full sunlight, you know, for maximum photosynthesis. Well, inside that flask it would get very hot so I rigged up a system where the base of the flask was emerged in a water bath, cool water bath, to keep the root zone temperature about seventy, seventy-five degrees. And I had reflective services, you know, to reflect he light and all that sort of stuff and at times I'd have four hundred of these things. I'd had a greenhouse bench that was forty foot long, four foot wide and every ten inch centers was a flask. That's how

many we were running. Well, one weekend we had a power failure. Lightning storm came through and it was one of the rare weekends that I didn't work. I was gone somewhere else. I forgot what it was. But the power outage went off, according to the time clocks the power went off about five o'clock on the afternoon of Friday and didn't come back on until late Sunday night. Well, Saturday and Sunday it was like a hundred degrees in that greenhouse. Well, in these flasks I had pine seedlings and I was testing about six or seven different species of ecto-mycorrhizal fungi using them as my model, if you will, for the disease work that I was doing. Well, I went back in there on Monday morning and eighty percent of all of my plants were dead. I mean just, six months of research just flushed down the toilet, and all of a sudden I look around and wait a minute, there are some of these plants growing beautifully, some of these pine seedlings. Inside the flask was covered with condensation and everything else. You know, it got hot as hell in there and there are just little pine seedlings just as happy as can be. Well, I pulled those flasks out separately and they were all inoculated with a fungus, Pisolithus tinctorius. Don't worry about that, a puffball. You look at all the other ones they were dead. All the other seedlings symbiotic with the other species of fungi were dead as a hammer, except for Pisolithus tinctorius. I said, huh, what the hell is that all about. It also happened to be the easiest one to work with in this aseptic flask system because it grew vegetatively very well. Well, I more or less put that back in the back of my brain for a while and as a coincidence, it's amazing, the year that I finished my Ph.D. in '66, now this discovery was made in '64. Discovered serendipity in '64, that this fungus has got extremely high temperature tolerance and bestows upon pine seedlings high temperature tolerance. Right?

HKS: Yeah.

DM: What's the significance of that? Well, hell, I don't know. Just about that time Dr. Schramm, S-C-H-R-A-M-M, in Pennsylvania published, he's a botanist at Slippery Rock University, published a paper, a monograph, more or less showing the natural revegetation of coal mining sites where they have strip mined for coal and left behind a very acid surface material, and how nature can reforest these areas. Well, he's showing all these pines growing in there and oak and you see this brown puffball on the ground. Turns out to be Pisolithus tinctorius puffball. And one of the major issues that he discussed in there that it is so difficult for nature to naturally revegetate these areas because the surface temperature being black exceeded a hundred and thirty degrees Fahrenheit for most of the summer months. Now here's a fungus that I just found and so one of the first chores that I had, Craig Bryan, thank God for it, was still in Athens, the guy who guided me through my B.S. and master's program. We got in the car and we drove up to Kentucky and Virginia where all the strip mine coal areas were. Pete, everywhere we went were puffballs, some of them this big. I kid you not, bigger than your head. I've got photographs of some of them. This one ecto-mycorrhizal, Pisolithus tinctorius, all over these acid Ph2 coal spores. I said damn! Now my job in Athens was to continue exploring the disease relationship, disease function, disease control function of ecto-mycorrhizae, which I was doing. I said this dang fungus is naturally occurring. It's got to be erratic as hell. I mean if a seed blows in, germinates, if it doesn't acquire this fungus pretty quick it's dead. So what you're seeing is this erratic reforestation, tremendous differences in age classes and stuff like that. And we said well, we know that some of the coal companies were planting trees on their on because this was before the reclamation laws. And we went in and looked over some of these sites and we talked to some of their engineers who hired people to plant trees and said how many trees did you plant. Well,

we planted eight hundred per acre. Well, they had about ten left, ten surviving. Pete, without exception we could go on those ten surviving trees and find this puffball and look into the root system and identify this golden colored mycelium and this golden ecto-mycorrhizae **{??? one word inaudible 078}**. It's unbelievable, of course, weird. It puts goose bumps on you, right? This is an incredible discovery. So basically the challenge was, it was two things. They working hypothesis was very simple. If these trees are growing, surviving, on this extremely hostile site because of this fungus and knowing that the fungus naturally occurs quite erratically, it's all from spores blowing in. Of course, back in there we didn't know that spores were functional. Didn't know that. Could we develop a method of putting the fungus, inoculating the fungus, introducing the fungus onto the root system just like we did with the aseptic flask? We'd do it outside in a nursery and mass produce tree seedlings with this specific ecto-mycorrhizal fungus on a root system and have successful mine plan reclamation. That was the concept. Well, it's a lot easier said than done because I tried all kinds of crazy hair brained schemes that other people had suggested and they all failed. We tried repeating some of the failures that other scientists in other countries had done and just repeated their failures and they were absolutely right, it didn't work. We have in the Southeast we're blessed with an abundance of many, many species of ecto-mycorrhizal fungi that produce literally billions and billions of spores that are in the air. You cannot find a spot that is not naturally inoculated with these ecto-mycorrhizal fungus spores now. They die if there's not a host. So the first thing was and we were starting to look into to tree nurseries at that time and, of course, the nurseries were fumigated, standard procedure to control root disease and weeds and we said well, the fumigation eradicates all the native mycorrhizal fungi, therefore, anything we find on the trees let's say three months after fumigation after planting will be from the air. And we did. We confirmed it. We identified those that are the most

prevalent ones that come in by the air. They were killing us. So I developed an electronically air filtered plant growth room about the size of this room. Bombard, steal money, me and my technicians and Craig Bryan were working that nights and weekends putting this damn God awful Rube Goldberg together. Two by four frame, polyethylene plastic lining, pulled the window air conditioner out of a little house to cool it off. And they had just come out with the people who have allergies using these electronic air filters. They said they even take cigarette smoke out of the air. We went and bought one. My Lord, it cost two hundred dollars and we put it inside the duct work of the air conditioner system. Cranked that sucker up and we tested it and we got spores of common fungi blowing through there and they collected them on a petrie dish on the other side. My God, these things were incredible. They filtered the dang fungal spores from the air just like their advertisement. So long story short, we had now an environment where we could grow plants in the open outside of these flasks, in the open. Of course, it was semi open because it was all an electronically air filtered enclosure inside of a greenhouse. It worked. We were with that able to develop through a great deal of trial and error how to grow these fungi in pure culture. Turned out we grew them in vermiculite peat moss, the same substrate that we grew the pine seedlings on, we just enriched it with a carbon source. They grew like the devil in it. And that vegetative inoculums in vermiculite peat moss was a base inoculum. We'd wash it and dry it and that process took five years because it was a lot of failure. But the growth room allowed us the testing area away from the flasks because they were killing us. Well, by chance we were able to work out inoculation techniques with not just Pisolithus but several other fungi that we were working with. And with the growth room, this polyethylene plastic enclosure we were able to grow in flats loblolly, red pine, pitch pine, Virginia pine as test pine species just to see what species was symbiotic with and every one we put it on worked. And I'm talking about,

Pete, we pulled our root system out looked like someone had just glued yellow cotton all over it. It was that much of the fungus on there. I said we got all these beautiful plants. I don't need but five or six for assessments. I've got a flat here with fifty in it. So I picked up the phone and called some colleagues up at Clarion University in Pennsylvania that surrounded by strip mine coal spores and a buddy of mine up there at Kentucky, another in Virginia. Now keep in mind we had no funds for travel back in those days, zero. So Craig Bryan and my lead technician Billy Daniel, bless his soul, and I, got in a Chevrolet station wagon, crammed the back full of these flasks of inoculated and non-inoculated plants and we took off. We left on a Monday morning and we returned Friday night but we drove to outside of Pittsburgh non-stop. Stayed all three of us in a motel room, one motel room, and eating nothing but white bread, bologna, and Co-Colas. That was it. Left Clarion, drove down to Kentucky, planted these trees experimentally. Then from there went to Virginia and planted the trees experimentally and we got home Friday night at no cost to the taxpayer because Craig Bryan and I picked up all the costs ourselves. All we did was charge the gas.

HKS: If I remember, about this time the Forest Service was much engaged in strip mine reclamation, which I thought was put the dirt back and putting trees on it. Were you keyed into that?

DM: Yes, yes.

HKS: I would have thought they would have had some money for you.

DM: Not until we proved our point. Now you're jumping ahead of yourself. Now once all of a sudden we had contacts up there. I mean knowledgeable reclamation people, the Kentucky group was the Forest Service in, doggone it, I forgot the name of that lab. But they were the ones that were with us when we were examining some of these coal spores and finding Pisolithus. They were amazed too because we could dig into the root system and show the same mycelium at the base of the puffball tying into the root system. Said look at that, that tree's there because of this I think. We got a lot of people and all of a sudden after about two months we started getting calls. This guy called from Clarion and said they're all dead. I said what's all dead. All your non-mycorrhizal plants are dead. That's predictable. What about the ones at PT? He said well, out of the fifty you planted we found two dead. You're talking about ninety-eight percent survival. What is this? He said yeah, and they've grown two inches. What! Of course, you only had Polaroid photograph, cameras then and so he said I'm mailing to you some Polaroid photographs. And lo and behold, my God, it was incredible! Here are these, and we had fairly good chemical analysis. Ph in the soil ranged from 2.2 to about 2.7. We did not fertilize, irrigate, nothing, did not lime, nothing, just planted them. Then the guys from the, I had the name of that lab in Kentucky, calls and says well, I hope you're going to be satisfied with this. What? He said all your non-mycorrhizal plants are dead, hundred percent. And he said I'm sorry to say that seven of the fifty inoculated were dead but coons got two of them. Then we got the same report from Virginia. Damn, it works. And, of course, what I didn't say is that we also had flats with the same species of pine inoculated with other species of mycorrhizal fungi, not just Pisolithus. All of them died too just like the controls that had none at all.

Well, we said okay, we're still not ready to go outside yet to an open face nursery, open-air nursery, because we still didn't know how to compete. We did not know how to create an inoculum that we could put into a fumigated nursery soil that was sufficiently strong enough to out compete the naturally occurring stuff coming from the air for the root system, because they're all competing for that carbon on the same root system. Well, I said well, Mother Nature is doing it with spores. Let's find out if PT spores work. Bam! Yeah. We set up all kinds of elaborate schemes, you know. From this research I came to a very good conclusion. Always look for the simple answer first, because everyone is saying it's so complicated. You're never going to be able to inoculate when you've got all this fertilizer in these tree nurseries. High fertility is going to inhibit mycorrhizal fungi. I said have you ever been to a tree nursery and looked at a root system. They're totally mycorrhizal. And look at all this fertilizer they put on them. Look at all the pesticides they're putting on. Doesn't seem to bother Mother Nature a damn bit. Why do you think that should be a handicap for us? So we said heck with this. All my advisors, Don, you can't do it with all the pesticides, the high nitrogen fertilizations and all this other stuff, just no way. First study was a hundred percent success. But all of it was done first in that growth room where we could exclude the competition of all the other airborne spores. Basically it turned out to be one specific fungus we had to fight, which we confirmed naturally occurred in all tree nurseries throughout the world, Russia, Poland, Germany, Central and South America. Wherever they brought in this soil, this one fungus, **{??? tulufria teresoras 217}** was the incumbent. It was everywhere, everywhere we went.

So anyway, we added now a technique that we could go outside in a micro plot, we created a micro plot nursery, basically duplicated a commercial tree nursery but just put it in micro plots

about three foot, by three foot, the whole series. We had five hundred of these things set up. And you'd fill them up with fumigated soil and start them as if that's a real nursery and start testing all kinds of things. And, Pete, everything we did was new. Everything we did was publishable. That's why you could have two hundred and fifty publications because you do ten experiments a year you've got ten damn publications. And we all worked as a team. I mean everybody is working on certain segments of it.

I think it's important at this time also, I was project leader or institute director from 1971-94 when I retired. What's that, thirty-three years? I hired one secretary. I hired one technician and I hired one scientist during that entire period of time. Our project was a dumping site for scientists that would be transferred in. We were basically considered, and I'm dead serious about this, we were considered a project of Peck's Bad Boys or rejects and it's amazing, in two years we became the most productive Forest Service project in the entire Forest Service and we maintained that image for sixteen years. Right? Received the greatest number of awards, outstanding achievements, and the greatest number of publications all because of Pisolithus tinctorius. Because the simple philosophy was it's as important to find out where it is not effective as it is to prove where it's effective. So we set our sights all over the world. About this time here comes Bob Buckman. It was interesting that he knew about this. I read the book, your book on him, where he said that I was going to leave the Forest Service. No, I wasn't. I just want the rumor to go out, because I was seeking funding and more than that, have to realize a project, a Southeastern station project was restricted almost to the southeastern area without getting permission to cross into another station area. For me to go to Virginia and Kentucky we bootlegged.

HKS: Funding or is that just turf?

DM: Turf protection more or less. I'm not saying this is what the station directors felt but rather than dilute elsewhere concentrate your efforts in our station area. Well, Buckman did two things. First he loved what we were doing. He really complimented the research that we had been doing with the growth room and I told him, I said I need a new growth room, a more elaborate one. This one here is falling apart. I mean the dang polyethylene plastic breaks, you know, and you contaminate the room. And he said well, how much money are you going to need. I said about twenty-five thousand dollars. I just pulled it off the top of my head. I had no idea what it was going to cost. Ended up costing just about that much. And I said I'd like to have the authority to follow the research direction wherever it goes. He said you can't do that with a project. I said I know. He said all right, what about an institute. I had no idea what that was. He said we can give you a status of an institute and it will give you worldwide area that you can work with. The only thing of it is, you've got to get your own funding. We don't recommend that you use station legislatively appropriated funds for your international travel. You're going to have to find a funding from outside sources. If you can it would look better. So he was my mentor in that respect. He created an institute and we called it the Institute for Mycorrhizal Research and Development, IMRD, in 1975 I guess it was.

HKS: That's the date here on the outline.

DM: Okay. And like I said, I wasn't too sure what the hell it meant but let's put it this way, we were defining each day what it meant. Like we were, we were unorthodox.

HKS: Is this like a pioneer unit?

DM: Yeah, it was, well, Bob didn't care for pioneer units very much because what you do you get a highly concentrated researcher and the guy retires, everything falls apart. Well, at least with an institute type of thing you can have continuity the way he viewed it and I agreed with him. We had a couple of pioneering units in the station and they did some incredible work. Lou Metz had one on forest mites but it was a one-man unit, where he was funded by himself. And Lou Metz was an outstanding scientist, but he preferred to work alone. There may have been another one in Florida.

HKS: Peter Koch?

DM: He was gone by that time.

HKS: Okay.

DM: Yeah, he was in the Southern station. He was in Louisiana on reforestation. He did incredible research on reforestation to nursery production. But I had a staff, at this time I had Craig Bryan and when I returned to Athens the station had hired the first forest nematologist in the Forest Service, John **{??? Ruley 311}** and he was in Athens with the project. Andy Campbell

was project leader and Andy retired in 1971 and he recommended me for project leader and here I'm a young punk, right? I mean you've got all these senior guys. I said what do you guys say. They made me project leader. I said I'm not applying for the job. They just offered it to me. What do you think? Fantastic, go for it. Because we're all friends, very close friends. We fish together. We camp together. Well, this was still the project, the soil borne organism project and I was project leader and all of a sudden, we wanted to grow. I needed some more this, this, this, some how or another. Well, they closed down a forest management unit and Dr. Paul Karmatic asked to be transferred to my unit. Now Paul is a unique individual. To him a part-time job is forty hours a week and fulltime is eighty hours a week. Brilliant, but no one thought so, unorthodox, unique way of communicating and explaining phenomena but one of the keenest observers that I've ever seen. Anyway, we gladly accepted him.

Well, about this time the mycorrhizal field was opening up others and we needed to look into the importance of endo-mycorrhizal fungi, those that form not by mushrooms and puffballs, by a unique group of fungi that very closed related to **{??? Phytophera 342}**. At that time they were called endogone, E-N-D-O-G-O-N-E. They've now been reclassified and everything else, glomus primarily. But anyway, these fungi there's about a hundred and fifty species of them now we know. There's probably a helluva lot more. The more we look the more we find. But form mycorrhizae with eighty-five percent of the three hundred thousand species of green plants on this planet. And about that time Jim **{??? Gerdeman 350}**, Dr. Jim **{??? Gerdeman 351}** at University of Illinois in Urbana, plant pathologist, he started looking at roots just like I did and seeing all these brown round things, big, that everybody assumed were insect egg masses, or nematode egg masses, that turned out to be spores of the endo-mycorrhizal fungi, which are the

largest spores produced by new fungi in the world. Some of them you can actually see with your eye. Two hundred and fifty microns, that's a quarter of a millimeter, right? So he's publishing these papers, you know, world's biggest fungi, and this type of thing, more or less to get people's attention. Well, everyone thought he was a flake. What I didn't mention, when I was at N.C. State I took a lot of courses in soils and root disease. These nematodologists would typically, you probably don't want to hear this, it's too long and drawn out. But anyway, they did not appreciate the role of endo-mycorrhizal fungi in agricultural products. {**??? Gerdeman 373**} had published a paper that every agricultural crop that he monitored up in Illinois had naturally occurring, at that time they were called, endo-mycorrhiza. VAM, vesicular arbuscular mycorrhiza, VAM. Don't worry about that. Hell, I just, in the southern states here we have these yearly corn draws. You know, they've got new varieties of corn they're testing at strategic locations here in the South and just by chance one of the ARS scientists at N.C. State was working on that program and he was getting root samples back to look for nematodes from all over the South. So I got some of those samples to look for endo-mycorrhizae, every one of them, and I showed them to him and he said my God, look what we've been overlooking, you know. What does this mean? I said I have no idea. Do we contact Jim {**??? Gerdeman 391**} now and he said of course, that's what we're saying. All these plants have them if the soil's not fumigated. And then we started looking at trees, sweet gum, maple, and lo and behold, we find the same thing. They're just completely mycorrhizal. You have to keep in mind when this was. This was the early 60s and was not a common, the eleventh commandment. Today we accept that. We know that. But back then we didn't. So I wanted somebody to start working on endo-mycorrhizal forest trees and Paul Karmatic who was a root physiologist, did a tremendous amount of work on root configuration, root morphology, cytology, said this was his stuff. The thing about the YAM

fungi, the endo-mycorrhizal fungi, we cannot grow them in the laboratory like we can with the ecto-mycorrhizal fungi. The common method of growing them was to get fumigated soil, get some of the spores, put them in that fumigated soil, and plant sorghum on it and let the sorghum roots acquire the fungus, reproduce the fungus, harvest the top, harvest the entire root system in soil, grind it all up and use that for inoculum. The whole world was doing that. Very little definition, we could not quantify very well what was in it. All we knew is that we could use that let's say ten grams for specific volume of soil and we got mycorrhizal development and that's what we're looking for. Paul began work in some of the micro plots and the results were incredible. Found out the obligate requirement of all of the eastern hardwoods that did not form ecto-mycorrhizae had the obligate requirement for endo-mycorrhizae. And he did a magnificent job, whole series of papers.

Tape 2, Side A

HKS: Don Marx interview, June 20, 2005, Tape 2. Krugman, I didn't know he was in this business. I mean I knew—

DM: Who?

HKS: Stan Krugman.

DM: Oh, yeah, well he was later on when he started seeing, I've not gone to this stage yet, where we're now in operational nurseries with the technology, some years away from where I am now, but Keith Shea, pathologist, of course.

HKS: I know him.

DM: Yeah, and Stan Krugman all became supporters of what we were doing and got us involved in various symposiums and stuff like this all over the world so we could talk about it, communicate it. Got me some funding. I'll get to that in a few minutes. All right, where are we now? We're now in micro plots where we got so excited about that we almost died. We called in everybody all over the world. You got to see this tree. One of the classical pioneers was Dr. A. B. Hatch, H-A-T-C-H. In fact, that probably was a name mentioned when you took, the mycorrhizal thing was mentioned to you in 1955. I'll bet you fifty dollars right now that it was a work of Dr. A. B. Hatch up at Harvard, Black Forest, Harvard Forest. He, I'm getting ahead of myself now. Nineteen sixty-nine, this is after N.C. State and we got the growth room now and all this other stuff and my dissertation publications had just been published. We got five papers out of it and it just changed everything. Not only were mycorrhizal fungi beneficial for mineral nutrient, the absorption of water but also biological controls. And this just, the flags went up and hooting and hollering and all this other stuff, incredible. Jim **{??? Gerdeman 017}** and Ed Haskell at the Forest Service in Beltsville put together the first North American conference on mycorrhizae at the University of Illinois where Jim **{??? Gerdeman's 025}** school and we assembled all of the world people who could spell the word. And had all kinds of speakers and everything else. In fact, this is, and all the big names were there. And A. B. Hatch who is one of

these guys that his monograph he published in '36 I think was basically, one or two others, were basically the United States Bible on mycorrhiza. Everything else had come up from Scandinavia. Of course, as soon as you cross the ocean the world changes everyone thought, you know. Of course, we now know what's far more common than we think. Everything is more or less common. But after that conference, even though it's not published in there, I gave a very, over beer in the evening would talk about my growth room and A. B. said I tried to build one of those in 1936. Of course, it didn't have electronic filtration. He was using all kind of air conditioner filters and cotton mesh and stuff like that so didn't work, had the same idea. It took thirty years before we changed. But he says, he was the fermentation director for Eli Lily for thirty-five years and he'd just retired in '69. He said can I come to Athens and work with you. My God, here's one of the disciples. I mean this is one of the gods, right? Yeah, of course. So he actually moved his entire family to not too far outside of Athens and he worked in this growth room. Now by this time we're getting money from Buckman to redesign the growth room, make a better growth room. Long story short, two year period I had him look at the micro plots out there and he called some friends. Like I said, we were having weekly meetings, people coming from all over the world, well, mainly from the United States. This can't be done. He said no, it can't be done. Everybody else before you have tried it and it didn't work. All of a sudden you come up, well, they didn't pick the right fungus, just by chance. So anyway we wrote a paper to publish this. We finished the research in 1973. We finally got it published in 1976 because it was rejected by every major journal. There's no way that you can identify the mycorrhizae produced by these specific fungi as easy as you say you can.

HKS: That's peer review talking?

DM: Oh, yeah.

HKS: You sent it out to peer reviewers?

DM: Oh, yeah, right.

HKS: And your so-called peers?

DM: Well, they weren't sent to mycorrhizal researchers. They were sent to other people. I wasn't too sure who they were. Anyway, I have three rules of proof. First, I added this fungus to these plots and I didn't add it to these plots. Okay? Puffballs produced only in this plot, none produced in this plot. That's first rule. Second, the golden mustard yellow mycelium that's associated with the puffball grows to the roots. I did not have any of that in the control. Third, I could obtain these mycorrhizae, surface sterilize them, plate them out on an artificial medium, and recover only Pisolithus. Wouldn't accept them. Again coincidence. In 1972 they developed a fluorescent antibody technique, which precedes the DNA identification. This is used in **{??? polymerase enzyme 072}** detection. We could inject rabbits with whatever you're looking for, a protein, an antibody, for the rabbit to produce an anogene, excuse me, for the rabbit to produce an antibody against the anogene that we injected into the rabbit. We bled the rabbit and then separated it and all this other stuff and developed an antibody that we could tag with a fluorescent dye. We then could use that fluorescent dye, which was specific, that we tested against like seventy-five fungi and it only glowed in the dark with Pisolithus. They finally let us publish it, as a rule of proof,

the final rule of proof. Now after that we had no problem. People would accept that man knows what he's talking about, that he can with his eyeball, no magnification, can identify Pisolithus on the roots of a pine tree, oak, spruce fir, whatever, and quantify it. **{Several words inaudible 083}** we train them to do the same thing. Once that was published then bells and whistles and flags. So 1977 we sponsored the third North American conference on mycorrhizae in Athens. We had set up the micro plot nursery as a you-won't-believe-what-you're-going-to-see. We put out oak trees and about eight or ten species of pine. They even grew in Ponderosa and lodgepole pine, you know, way out of our range, but in this nursery to show we could not find a tree host that normally forms ecto-mycorrhizae that Pisolithus would not form mycorrhizae on it. And we tested Moroccan, cedar, and every conceivable thing in the world. So ended up, it's in here. [sound of looking through papers.] I think I'm missing a page here. So anyway, the, we dropped a page out of this thing, Selina. I think, wait a minute. Anyway, we had scientists from twenty-eight countries. Had three hundred scientists. A third page, Sugar, is there a page over there with that on it? All the big names, we were able to acquire funding from the National Science Foundation to pay for the travel costs of some of the big boys. But what was really exciting that we had in the advertisement of this thing that they will see the technique first time ever, technique that potentially could be used to inoculate pine trees, pure culture, and tropics. That was my central thing. We knew we could do it for coal spores. Like I said, I'm preceding myself here a little bit. But after the NACAM we couldn't get them out of the house. We actually put several of them up in our home for two weeks that stayed to find out more about it. Anyway, we became a center of excellence primarily because of one fungus. We trained scientists from all over the world that would come in two days, two weeks, two months, China, India, Pakistan, Morocco, Mexico, Venezuela, Brazil, throughout all of Europe, Scandinavia, Canada, like a

meeting of NATO. At times we would have six visiting scientists from six different countries and maybe two of them would speak English, you know, or vaguely we could translate. But they all came to learn the technique and we had developed a streamline method of teaching it for them. Of course, gave away no secrets. Everything we have is yours. Poland, Russia, this was beyond the eastern block back in those days where they came with their interpreters. I got a synopsis of it somewhere in here. Over a period of something like twenty years we had four hundred and thirty-five scientists that visited.

Key was, again like I said earlier, it was important for us to learn where it was not effective as it was where it was effective. Needless to say, we now had micro plots. Said okay, now, can we go into conventional tree nurseries with this technique too. One step at a time, you know. You go from the aseptic flask to the flats in the growth room, electronically air-filtered growth room, then into to micro plots in an assimilated nursery operation, and then a real nursery. Well, I knew nothing about real nurseries. Well, a buddy of mine from Duke, Ed Cordell, forest pathologist working for the State and Private Forest, pest management of **{??? stasopea 141}**, stationed at Asheville, working in Region 8, was extremely knowledgeable in nursery diseases. He was a pathologist looking at nursery diseases of our commercial nurseries, state and private nurseries, which at that time we had like eighty in the southeastern region, these nurseries. So we had this southern forest pathologists meeting or something and he was there and I was talking to him. Ed, I said what do you know about the work we've been doing. He said well, I've been following it quite a bit. He said it's interesting stuff. I said Ed, I've got to have someone show me what a nursery looks like. We had only visited a few. He said well, hell, what do you want. I said what I want to do is mass produce this fungus in my lab and then collect spores of it, vegetative spores,

and go in these nurseries and test it to see if it works. Okay, 1975, now keep in mind we still hadn't published that first micro plot paper because it had been rejected but we already knew we could do it. So we go into nurseries in Florida, North Carolina, and Virginia. He sets it up for us. Fumigated soils, three different species of pine, at each of the three nurseries, well replicated plots that we had we could inoculate with the vermiculite base, vegetative inoculum and with spores and a control, three treatments in these nurseries. Well, it took some arm bending to get the nurserymen to give us permission to put, this in. What, you want to put in a fungus? We're trying to kill all the fungi. Right, because they think all fungi were bad, of course. Well, by mid year we're starting to get reports back that the inoculated plants are half again bigger than the controls. Now the controls have acquired the naturally occurring ecto-mycorrhizal fungi from the air but that takes a couple or three months. Ours got it as soon as the seed germinated. And Ellis Cowling, who was a professor, forest pathologist at N.C. State who was on my committee when I finished at N.C. State, had heard about what was going on so he brought his graduate students over to that nursery in North Carolina to see this stuff. He called me and said that's the most incredible thing ever happened. Bam, bam, bam, bam. Took some photographs and was talking about it. So we got in the car, my technicians and Craig Bryan and I got in the car and we drove up at the acquired time because we said all right, mid year we're going to make an assessment, you know. We're not going to change anything. We have a plan. And then when they go dormant we will lift them and make a total, complete quantitative assessment from the size of the trees, plants, how big of a root system, and we will have an out planting on routine reforestation sites in an area around these nurseries. That was our plan. Well, and it worked, incredible results from the nursery. We had three field site studies for each of the three nurseries, each one for each species of tree. And within two years we were seeing significant growth differences with the

inoculated plants. Where you had the most amounts of Pisolithus mycorrhizae, you had the most improvement, maybe not survival, because survival was almost always pretty good, but subsequent growth. Well, all of this took time. From the first time we put the first nursery experiment together til we got the results with two-year field studies, you're talking about three or four years. So all of this stuff is a three or four-year cycle and we're starting to get feedback now from the coal spore work. We're mass-producing trees at my nursery in Athens and out planting them anywhere. I mean you give me an area the size of this damn room I'm going to put a study in it. Lignite coal in the Texas area, bituminous coal in the central area, anthracite coal in Pennsylvania, each have their own problems, characteristics and everywhere we put these studies, we always had controls, we never fertilized, we never lined or changed Ph, we never irrigated, just plant the tree in the ground and walk away and the results were scary, literally scary. Controlled ten percent survival, we're getting ninety-five percent survival. In two years we got three-foot tall trees and the few controls that did live were still six inches. And I've got a thousand of these photographs for you.

About that time, 1977, the reclamation law came in, the federal reclamation law meaning the mining companies must reclaim. Well, they came in with the goddamn most idiotic goddamn way, shape or form, idiotic. And you bring in topsoil, four inches of topsoil and put it on a three-one slope. First rain it's down at the bottom. Whatever you put in that four-inch soil went down to the bottom also. And we followed behind those reclamations with our stuff very successfully. After 1977 any mining site prior to 1977 was classified as an abandoned mine site, abandoned mine land reclamation program, AML, abandoned mine land program. Every state thereafter charged a tax to the coal companies based on coal for so many cents a ton that went into a fund

to reclaim and revegetate the abandoned. We got involved in the Ohio abandoned mine land program in 1978 and they funded us two thousand dollars a year that would allow us to pay our transportation up there and their nursery, which is just south of Pittsburgh and inoculate a million plants for them to out plant. We did that with inoculum I produced at the Forest Service lab in Athens, right? We'd go up, inoculate the soil and incredible results. We did this through my retirement 1994. They would fund us anywhere from three to ten thousand dollars a year depending on what our scope, scale was that year. And these trees were planted in the national forest. What's that in Indiana, Ohio? It'll come to me in a minute, boy. It's amazing how it flows out the back. But we planted them on several national forests, state forests, also private lands, coal mine company land, wherever. To this day I think we've done through 2000 because our company has taken it over since, something like four hundred mining sites we have successfully reclaimed with this technology. When we started the operational reforestation was about five percent successful, meaning that if they did not get adequate stocking per acre after planting a thousand trees per acre, they had to go back and redo it. Our tests, we would make our tests on those that they had failures three times in a row. We've had success of PH 1.8 coal spores where there's actually sulfur crystals in the swab that you could see. Let me show you something here. This is the Savannah River site right up the road. You know where the bomb plant where they made plutonium and all that for the nuclear era right outside of Augusta? They've got these ash basins where the coal that they burned and then they'd dump the ash into this pit for thirty years, Ph 1.8. It has been buried like this since 1952. On the edges we're seeing little volunteer pines coming up with Pisolithus mycorrhizae. That's how we've reforested the entire area. This is it. There's the controls. There is it is after inoculation with PT.

HKS: Almost afraid to put your hand in that soil with acid like that.

DM: It eats your shoes off. Literally it would eat the soles. So of that acidity was so severe in areas that we worked on, we were working on the site when it was moist, that the sulfuric acid in the pyrite would literally eat the lacing, the stitching on the soles of your boots. It was that acid. And the trees loved it. Throwing Brer Rabbit back in the briar patch, what it boiled down to.

HKS: I don't think you've done this but maybe it went by me. Do you the physiological mechanism by how this works or only that it works? What I remember from my sophomore soils class it increases the surface area of the root and that's good for absorption.

DM: There's no question, absolutely right, that's it. You just hit it. Now the thing of it is to acquire it. Let the tree acquire it. First off, you can do nothing, nothing is going to happen unless the tree has a genetic capacity to do it. The tree must first produce a root system, second then we put the fungus on that root system, okay, and that's what we do in the nursery, we did in the nursery. Now once the tree is there it's producing carbon for the fungus and once that is satisfied, if the fungus has the capacity, the physiological capacity to grow into the acidic soil vegetatively, now you've got this increased surface area. I'll call it a bigger vacuum cleaner in my lectures. The way we describe it we're producing plants with a bigger vacuum cleaner on a root system. That's exactly right. The physiological process is the fungus must have the physiological capacity to grow into these extremely hostile soils. But keep in mind that one hundred percent of its factors for growth come from the host, the carbon. So you have to have a functional machine full of synthetic potential in the canopy to produce a carbon that's allocated to the root system to

support the mycorrhizal fungi and the new growth and as new growth grows fungus spreads in the roots. Now the main benefit the water.

HKS: Is it the mycorrhiza that survives?

DM: Yes.

HKS: Or not and the tree will survive if the mycorrhiza survives?

DM: No. If the tree dies, the fungus, if it's not in the dormant spore shape it dies too because it can only live vegetatively with the carbon from a living host.

HKS: Earlier you talked about that time when the power went off and then everything got hot. The heat resistance was for the mycorrhizae or for the tree itself?

DM: It gave the tree heat resistance. We still don't know what that is, still that know. That's such an artificial condition anyway I don't know. I think if we had waited another day they may have all been dead. I don't know. It was just one of these lucky things that we saw. What I'm still amazed at is that we have work underway, I'm really getting ahead of myself here but we have a mining company that's based on this technology that we're in the desert out west, hard rock mining areas and deserts out west in Nevada, Arizona, Utah, Wyoming, Montana with this technology going gangbusters. We'll get to that later. We're way ahead of ourselves now.

HKS: I was going to say the mining companies would be supporting the Institute. Gets them off of a very difficult hook.

DM: Yes. We received funding during the early developmental stage where we were doing the field tests. Peabody Coal, Arch Mineral, these coal associations that various states had would fund us. But keep in mind that it was illegal to get outside funding.

HKS: I thought the Institute could do that or have I got the chronology?

DM: Well, what I'm describing is prior to the Institute too see.

HKS: Okay.

DM: I was on the faculty at University of Georgia. I was on the graduate faculty at University of Georgia so these people would donate the money to University of Georgia and I'd get the money from the University of Georgia. The Forest Service knew nothing about it. They knew about it. But we could not obtain adequate funding from the normal procedures to cover even ten percent of the cost for us to do the research at the scale that we were doing it in because we were everywhere. So what we would do we would get funding through the Institute, Buckman's permission. You find the money, you know, as long as it's legal. Make sure you've got everything, paperwork covered and we did, co-op agreements and all this other stuff. But we received funding. One year we had thirty-two sources of funding, pulp and paper companies, mining companies, state forestry commissions, energy companies, Duke Power because they had

some slag problems that we worked on. All over that funded the research and all we asked for was travel and expense money. Like if I went to a coal spore to plant a tree, plant a study in Kentucky, all right, this is going to be three trips a year. Well, three trips, plant it, mid study, first year measurements and then next year measurements and so many visits, so many hours, so many man hours, so many technicians, so many meals and so many room and we actually asked it cost nineteen hundred and twenty-five dollars and we did that. We got funding from all over throughout just about every state in the United States I guess for a while.

HKS: It's really a constraint on outside funding. Is that Congress says that or is this a departmental rule or protective thing?

DM: Pete, I don't know. All I know is they said I couldn't do it.

HKS: Because I can see that it would be a concern where you'd be co-opted by all of this money coming in.

DM: Well, that I can understand the problem because it could become overpowering because everybody expected ten thousand dollars worth of research for five hundred dollars and they expect a report by Friday for a two-year study. We did a lot of tap dancing to satisfy these people. And I can understand why, you know, the Forest Service looked at this you can get misled down this golden path of all these funds and everything else and realize that for every dollar you got to work three dollars to answer it. Everybody expected, you know, we expect a complete chemical analysis of this material and everything else. I said fine but it's going to cost

you another five hundred dollars for that. You know, we don't do the chemical analysis and all that. We contract it out to, I had the name of that Kentucky lab just then because they had a tremendous coal mine lab there, chemical analysis. It will come to me. But we were collaborating worldwide, everybody in the United States. Like I said, it was very, very gratifying learning so much from these other people who were coming in, what their conditions were in those countries. Could we modify our protocol to accommodate what they had there in their country, and it became very apparent what we were going to have to do it do research in some of these countries. Because while we're there in the process, well, the primary purpose of the research would be training, but in the process of training we could get some field data. We're going to put some trees in the field. Starting about 19, not too long after that NACOM in Athens, people were saying look, I'm going to send you a plane ticket, round trip plane ticket. I'll pick up all the in country expenses. We want you to come in and put in a field trial in Morocco, Liberia, Nigeria, The Congo, Mexico, Venezuela, Brazil, other places in Africa, Australia. Well, over a period of about three years we did I think about twenty of them. They sent a round trip ticket. We'd have the inoculum. I'd have it in ice chests, have permission from quarantine people to introduce it. Most of these countries had no quarantines anyway. My biggest thing is can I bring it back, can I bring back stuff to evaluate.

HKS: I can see you at Kennedy with this chest full of stuff.

DM: Well, off record here, certain countries were a problem so I found out about the embassy pass. We would ship it to the American embassy and the embassy pass and couldn't be looked into when I got in the country.

Tape 2, Side B

DM: All I asked for was a round trip plane ticket, in country expenses.

HKS: I would think that, Bob Buckman is up on the Hill at budget time and he's got all these members of Congress, senators from coal mining states that have just been afflicted by the reclamation act, that money would have been no question from Congress for the Forest Service.

DM: Didn't work that way for some reason. Bob was an outstanding spokesman for the work we were doing but you have to realize that the people in charge of the reclamation program still didn't believe it, even though we brought them out on the site. We were actually, I was actually accused of treating a control with **{??? mercuric-chloride 008}** to kill them, I swear to God, by university professors from Ohio State who had been doing mine land reclamation work for twenty years. And this was so far out. Fungi, what are you talking about, because everything then was chemistry.

HKS: And all the stuff in the popular literature I have seen about reclamation, the miner, they put all the topsoil in a big pile, they dig the coal out and they fill it up and they put that topsoil.

DM: Well, that's where you have topsoil and that's what we're doing out west for example right now but the thing about it is, all the indigenous mycorrhizal fungi in that stockpile soil are dead. So it's a sterile environment. You don't have the natural population again. This research has

been done on that by the people at University of Wyoming. Once you stockpile it it's like a mulch pile. It's like a compost pile. The temperature inside kills everything off and the only thing, you've got an outside blanket, living fungi on that outside blanket. By the time that's all mixed up and diluted, so this is why we're successful out West with the inoculation program.

HKS: Were you ever curious and looked into some of the testimony on hearings on the reclamation act and what should happen and where this expertise came from, to put the topsoil on, had to be four inches thick and all of that?

DM: Agronomy, agronomists that did that. They wanted to put it back. They said my God, here in Kentucky we're going to finally have some land that doesn't have trees on it. We're going to grow corn, and that was the purpose of it. The thing about it is they did not address the biology of the soil. They addressed the physical aspects of it but not the biology of it. Thing about it is, on a three-one slope four inches of soil on a Ph2 you get grass growing, as soon as the roots hit that Ph2 they're dead and the entire hillside slips off after the first rain. It was successful in many places. In fact, in many states they took off the top of mountains and my God, they finally had a flat place, put an airport. Virginia, for example, West Virginia. Til this day, and this is now thirty years after the fact, we've had fifty publications on it. We have gone to mine land reclamation symposium meetings, etc., etc., at all scales, international, national, statewide, and have literally given dozens if not hundreds of talks and it is still not an accepted program, even though right now it's practical. Now I'm preceding myself here a great deal. The first nursery I mentioned that Dr. Ed Cordell, forest pest management, and I want this to be on record, without Ed Cordell very little of the field application would ever have been done because he knew how to do it. I

didn't. I learned from him. He was the one that had the contacts, the network among all the nurserymen and everything else and they had his respect. He'd say we're going to come in and we need ninety linear feet of three nursery beds for an experiment or whatever, and they would do that.

All right, so we're now in a position that we can mass-produce a variety of tree species with this one specific ecto-mycorrhizal fungus on the roots. Keep in mind we always have controls that have the naturally occurring fungi on the roots but not this Pisolithus and we're out planting these things everywhere. Set trials up in Oregon, Washington, with Jim Trappe and his group, with Randy Melin and those people. And again, like I said, it was as important for the technology to find out to limits to this fungus, where it was not successful. We were doing studies in Third World countries. Ed Cordell was not involved in any of those. He was not allowed to travel internationally. But we put in studies, like I said, Liberia. I forgot one, 1971 way before we knew we could do it in 1971 but we hadn't done it yet. But I was contacted by Church World Services to look into a forestation of the Peruvian Andes. That whole country, you know, earthquakes, everything slides off the top of the mountain. There are no deep rooted vegetation whatsoever. Everything is high elevation, nothing but grasses and forbs. And back in the '60s, early '60s, an unknown group, at least they would not tell me who they were, went throughout the Andes and planted trees, seedlings, pine trees, eucalyptus, couple of other species, and they wanted me to go in there and these never were inoculated, they were growing in a nursery in Lima, and they were trucked out and some of these were planted seventeen thousand feet. So the Forest Service said yeah, go, as long as they pay for it. So I flew into Lima, met with their officials and all this other stuff and we got in a doggone Land Rover, two months, driving all over the Peruvian Andes,

height about seventeen or eighteen thousand feet, looking for these dang pine trees. Well, we had a problem with communication. They spoke Ketchwa in certain areas and we had Portuguese speaking or Spanish speaking interpreters and not anyone could communicate perfectly. So I knew we were having trouble trying to find out, you know, where these places were so first pine trees I found I took a branch off and said, you know, where are these, you know. Because before I would say a long green leaf, well, they brought me to the cornfield. All right, there's a long green leaf, you know. [Laughter] I said well, we've got to communicate better than this because we're wasting a lot of time. But anyway, long story short, we found the trees, some of them still alive. All of them had ecto-mycorrhizae, some of the strangest fungi you ever saw in your life. But anyway, earthquake, got blown off the top of a mountain. Lost our pack animals and all this other stuff. Walked out on this knee for three days, split it together with eucalyptus firewood because all the bridges were blown out and had to get out of the country. But luckily I was finished. The job was done. And this has been a problem ever since but anyway that was my first adventure and it was very challenging. We slept on the ground. We slept in some of these abandoned huts but they were flea invested and, of course, we had to get the hell out of there. Begging for DDT to control the bugs. Hammocks, slept in one bed the whole time I was gone. It was a true, it was almost like the Marine Corp again, major language problem. I backpacked in portable fishing rod and reel and I had heard that the French had introduced trout in some of those high elevation lakes and every evening we would end up camping around a lake and I'd catch dinner with this. Like I said, at that time I smoked four packs of Marlboros a day and I'm up to seventeen thousand feet and I could out walk those people because even those big chested people, every hour they'd stop. But it was every day we would probably, well, some days we didn't have to walk at all, we just drove and got very close to some of the sites. But some of the

days we'd walk eight, nine, ten miles, you know. And got back home I made all the assessments of the samples I took and everything else and again this is a perfect example of why we should have pure culture introductions of these fungi and not the mass soil movement, because one of the nurseries that they wanted to establish to grow pine trees in was a former potato field and they were going to use, whatever inoculum I could come up with they were going to inoculate this soil and then move these plants from this local nursery all over Peru. That potato field had golden nematode in it. I brought samples back and my nematologist, John **{??? Ruley 105}**, confirmed it, that if they had used that they would have disseminated the golden nematode, which is the number one devastating nematode for potatoes. It would have completely locked that out. And we published that, and of course, I stopped it. But then politics got involved. That's not for record but we never did go into Peru with an inoculation program. It just didn't happen for several reasons, not because I didn't want to, just the simple fact that at that time politics and funding and other barriers there just didn't do it.

We're now through about what, oh the international, Liberia, got caught in a military coop and great difficulty getting out of the country. Thank God for the Marine Guard. They escorted me out to the airport and got me out of the country. They were machine gunning people on the streets. Bodies lying in the streets just like your typical African coup and I think I was the only white guy for about a million square miles. The President, Tolbert, was assassinated and President Doe became the new president and everybody who owned property, any of the old people who settled Liberia, they were annihilated. Anybody who had an education was annihilated. Any successful businessman was annihilated. The officers, the military, were annihilated and one of the interesting encounters I had was with a sixteen, looked like a sixteen-

year-old major with corporal stripes. He'd previously been a corporal, made major. It really messed up the country, needless to say. The people I worked with half of them were killed. The Swedish government wanted to go on to the **{??? Stora 134}** with Sweden, **{??? who eventually gave me the Wallenberg 035}**, wanted to go into the tropics to grow long fiber pine because they were running out in Scandinavia and they picked several countries in the tropical areas to do it. Liberia was one of them. I had taught a workshop in Ghana and some of the people came and we set up research studies, big field plots. This is where Stan Krugman because this became part of forest management and he was very important in getting me the permission to go into Liberia, Ghana, or Nigeria, Congo, and those countries like that to do this research. Not that anyone else was supporting it but we were multi disciplinary. We were pathology, soils, and forest management, timber management, all three. Had international forestry involved in it. But we got funding from OICD, from USAID, from Forest Service International Forestry, wherever we could, UNESCO, NATO, some of the international foundations, Rockefeller. In many cases it came to us, you know, can you possibly do some research here in Morocco. Yeah, how much, five thousand dollars, okay, do it.

But all this happened from about 1977 to 1987, a decade, about ten years. Very, very intense period, hitting six and seven countries a year. Gone from home a lot, Selina is raising our five kids alone, you know, this type of thing. Well, she got fed up with it. She said dang it, you're not going alone anymore. I'm going with you. I said well, you got to go as a Forest Service volunteer. She said fine. I said well, you've got to go with your own money. So she got a job cleaning houses, cleaning new houses there, and her primary source of income was used to go with me to India, to Pakistan, to China, to Mexico, to Brazil, Venezuela, Germany, right? Turns

out she's a dang fine technician too til this day. But it was very exciting, very rewarding. Like I said, a lot of people were responsible for everything coming to the completion. I had a staff back home in Athens, incredible staff, technicians and scientists that were all still doing their thing. Each one had their own specific area. Charlie Berry, he used to work air pollution with George Hepting, was transferred in. He got looking at municipal bio solids as an organic amendment for adverse sites barrow pits. We got him funded at Savannah River site to do that. To this day that is the EPA example of land application of municipal bio solids, our study at the Savannah River site on that barrow pit reclamation. We got trees today twenty years old, fourteen inches in diameter, sixty feet tall that received one half inch application of bio solids on a clay soil that you would not believe, one application. And that's now the EPA example of this is what you can do with land application of municipal bio solids and that was primarily Charlie Berry's work. He did the same type of work up at Copperhill, Tennessee, which is in this area of Tennessee air pollution of sulphur dioxide from open pit mining and burning overburden to get copper. Sulphur dioxide emission killed everything green in a basin of sixty-five thousand acres. And we went up there in '68 to do research on it, '70, with the mycorrhizal technology and bio solids and it was still a biological desert. But we proved that we could do it. Common sense changed the physical biological chemical problems in the soil. Correct those and it's amazing, plants were beginning to grow. And we did that in many locations with Charlie. Ed Haskell was moved in. Put him in charge of the long leaf program because we had a major problem in the South with artificial regeneration of long leaf. The seedling morphology was weird. It was no stem, just a bulb, just a butt, and it had tremendous problems on artificial reforestation. Long leaf pine was coming back in as a major species because it's the home of the red-cockaded woodpecker. So we got our funding through the threatened and endangered species act to do research on long leaf pine.

There was not enough long leaf pine to support the predicted population of this threatened and endangered red-cockaded woodpecker. That work again was done at the Savannah River site. Again I'd like to go on record. I can't say enough about them because they funded us. The Department of Energy through the Forest Service, Region 8, and primarily through one man John Irwin, I-R-W-I-N, the forest manager, saw what we were doing and said this is incredible, this is what we want here. We're going to use this site. You use this site as an experimental forest because we've got every kind of site you can possibly think of, good quality, poor quality, barrow pits, uplands, wetlands, you name it. And so we used it and we received, our project over a period of 1970, twenty years, an average of about two hundred thousand dollars a year funding to support everything we did. And I'll get into later what some of those other things were. Keep in mind that the Savannah River site was receiving bad news, bad press. All the environmental pollution and possible radioactive contamination of groundwater and all this other stuff, they wore the black hats and we came and gave them white hats. We can do good stuff. We can help Mother Nature heal the wounds, the barrow pits and the other problem areas we had. The solution to pollution is dilution and we went in with programs and showed how they could get light contaminated tridium water and irrigate it through a forest ecosystem and it no longer is there, nondectectable. We put together an irrigation, forest irrigation program for low grade tridium and completely, using the forest biomass as a dilution factor. But we did, like I said, a lot of creative things with them. They asked us can you do this, can you do that. Of course, a lot of times, no, the cow can't jump over the moon. There are certain biological limits to everything. But we did a lot of creative things with them, cranked out a lot of publications. Paul Karmatic, Charlie Berry, Glen Haskell, myself, by this time Craig Bryan had retired. Ed Cordell worked with us on so much of this getting support. At one time we had support from six regions of the

Forest Service, working with up to twelve Forest Service scientists, sixteen university professors, at thirty-eight nursery locations in the United States in one year. Now that program, we knew that we had something that was pretty good. There was no way though that my lab, the Institute for Mycorrhizal Research and Development, could produce the world supply. We're not going to do that. It's not our job. What we need to do is look for a commercial production. So long story short, we got Abbott Pharmaceutical Labs, the giant silo size fermenters, interested in trying to produce the vegetative inoculum of Pisolithus, the vermiculite peat moss base. So we set up a co-op agreement with them where we would test nationally our strain of Pisolithus, produced by my technique, compare it to however they're going to produce it a variety of ways with my guidance and a control. We get the inoculum we got to test it everywhere. This again where Ed Cordell was invaluable. From 1977, again this was all, the world's crashing down on us from 1977 through 1980. Abbott Labs they funded us very handsomely because I was chartering airplanes. In order for us to put in nursery experiments with this experimental inoculum at operational nursery, whether it's industry, state, or federal nurseries, we have a planting window. If you look at central Florida to Wisconsin, I'm talking about nationwide now, that we've got about a six-week planting window. All the seeds are planted in that six-week period, starting in Florida in May and ending up in Wisconsin, I mean March in Florida, ended up in May in Wisconsin. Well, there's no way we're going to get in a car and drive to all of these places. So we got permission from the Forest Service, Bob Buckman was helpful in this respect, to charter a licensed Forest Service approved chartered airline service flying a two motor Piper Aztec that would carry pilot plus five and an additional seven hundred and fifty pounds. I got these ice chests full of inoculum. Anyway, Abbott started producing experimental formulations for us and we did testing. I got to go back to the records on this one. Fifty-four experiments in thirty-three bear root

nurseries and eight container nurseries in thirty-two states in Canada on fifteen species of trees and from every successful nursery experiment we put in an out planting, field planting trough in the field, a natural place. Our funding, we planted, we were in corporation with all the big forest products industries, International Paper, Weyerhaeuser, all the big guys, almost every state nursery. One year we had thirty-eight nursery experiments in twenty-seven states. And what we did, on Monday morning the plane would could out of Macon, Georgia, fly to Athens, pick me and my crew up with ice chests, inoculum, fly to Asheville, pick up Ed Cordell, and then we're gone. One day, one day, we hit four states and put in five experiments in one day. We would fly and land in a cow pasture. Call in the state patrol, they'd open up a mile and a half of highway for us, back roads country, you know, fly in, land. Nurserymen would be there with a vehicle to pick us up. We'd go in the nursery and we had this thing streamlined to such a dang port that we could put in an eighteen plot experiment, lay it out, broadcast the inoculum, chop it in with a hoe, sow the seed, label it, and be back in the damn airplane in an hour and a half. I mean boom, boom, boom! And we did that from Florida, Georgia, South Carolina, North Carolina, Virginia, West Virginia, Indiana, Ohio, Wisconsin, Oklahoma, Texas, Arkansas, Louisiana, basically all the pine growing states as well as Nebraska, Oregon. We had to fly direct to Oregon in this airplane. But setting these research studies up everywhere. Ninety-five percent of them were successful. Half of the unsuccessful ones were because I screwed something up or the nurserymen screwed something up, like they didn't fumigate the soil in this section where they put us. But we have a monograph, I think I gave you a copy of it, as a result of this Abbott program that if nothing else we learned so much about forestry nurseries I published in one thing about much fertilizer they apply, how much pesticide they apply, because that hadn't been published. We didn't know that because a lot of these companies wouldn't admit to that but

working with these nurserymen they'd say sure, all of our records are open. We put in, we sprayed Ferbam for rust control fifty-six times this spring. Every time it rains here I go out and reapply it, fifty-six applications of four pounds per acre of Ferbam, right? Didn't hurt a thing as far as we saw. Controlled **{??? fusion formed 340}** rust. Anyway, but this was all part of the experiment. Ed Cordell, like I said, was the key guy that aimed us in these directions to help us line up all of these experiments.

Again, all during this time we had visitors from all over the world. We'd bring them to these nurseries, show them what we were doing. Graduate students, I've got it here somewhere the total number of graduate students from Penn State, Florida, Kentucky, Tennessee, Georgia, of course, Uganda, other places in Africa, Malaysia, Korea, India, Pakistan. I mean just, like I said, these people were could we come in and train. Yeah, do you have funding? Yeah. Fine, we got space. And fortunately some of them had funding to get there, didn't have funding to get home. And we worked very closely, again this is where our Washington people were very helpful, allowing us through immigration to get these people back home on an airplane. What other countries, the Philippines, just everywhere. People come in and they didn't have a place we'd put them up in our house. They'd stay with us. My kids, to this day, say Dad, it was like a meeting of NATO. You know, we'd come home from school and we had no idea who these three big African guys in African cloth, you know, very dignified. One became the chief of the Forest Service of Nigeria, he says because of the three-week training we gave him. Well, doesn't take much then, right? But it was an extremely exciting period and the thing about it is we developed to this day contacts all over the world. Many of the young students that became professors

became heads of departments and became presidents of universities. And that had a significant influence of what came later in these countries.

Let's see, we're now up to what period? All right, from 1978 to 1991 fifty-six invitational lectures at international conferences, thirty-one graduate students at seven universities, including New Zealand, Uganda, India, and Australia. Initiated over seventy corporate research studies. Officials to the Forest Service seventy. Total of four hundred and forty-six visitors, forty-three scientists studied. Like I said, a very busy period. During that time we also developed a method of putting the spores of Pisolithus on pine seed. Worked with **{??? Hilishod 398}** Seed Company. They were the first ones to develop encapsulated sugar beet seeds. Sugar beet's a very, very tiny seed and usually when they planted it they'd broadcast the seed and then go out and thin it. They developed a single seed encapsulated technique where they could very precision, it saved a lot of money, very big technology. Well, I heard about what they were doing and contacted them. They said this would be interesting for us. We want to see if we can do it too. Well, long story short, they sent their key scientist to Athens to work with us for two years and we're shipping encapsulated seed back to Sweden for them to encapsulate it back for us to test it and bottom line is yeah, we did it, direct seeding. Dropped the seed from a haroplane, inoculated. It was done in China and it works. It's just never been on a grand scale. We have the capacity in our company now to do that and we're gradually sticking our nose into that. Right now we're spread so damn thin it's almost impossible to breathe. But wherever we thought we could introduce the combination of the fungi and the trees, whether it's by seedling or seed, we found a way of doing it. We were developing a technology to do that. We did it with the seed

companies. They had the technology, fine, let's come together. And it worked very, very successful. We published on it.

Tape 3, Side A

HKS: Don Marx interview, June 20, 2005, Tape 3.

DM: And it's no more expensive than to do it any other way.

HKS: Do you know, did you do research, did other people tell you that there's other species of mycorrhizae that would do this? I mean you are talking about I don't know how may species of mycorrhizae are out there.

DM: There are thousands. Tests were made with others. Jim Trappe and his group tested several species of **{??? Rhyzifogan 005}**. We tested other species here. Pisolithus is unique. It has been confirmed to have a worldwide distribution. We've confirmed that. Throughout Russia, Poland, the Eastern Block, Baltics, throughout the tropics where there are now trees growing, Australia, even in Canada we've got published results of Pisolithus in Canada, positive results. You have to realize from all these nursery experiments there were field studies and for many of those field studies publications came out saying the effect on field performance. Most of them were very, very positive. Where they were not positive we found out why because of the aggressiveness of other fungi. Two things about Pisolithus is its extremely broad host range. We have not found a tree species anywhere in the world that if it normally forms ecto-mycorrhizae that it would form

ecto-mycorrhizae with Pisolithus, at least experimentally. There's no other fungus that has that range that we know about. Keep in mind most people stop looking. Also, the fungus, these puffballs, a one pound puffball contained two trillion, that's three commas, spores, one point two million spores per milligram. Do the math. That allows us quite many, many choices of commercial application using the spores of Pisolithus. You can go no more than this and inoculate the fifteen acre nursery. And we did that in Venezuela, Brazil. The reason that International Paper in co-op with the Venezuelan government's able to produce, grow pine plantations in the Sarada of Venezuela is because we introduced Pisolithus for them and they now are harvesting it from their field sites and coming back and inoculating the nursery, harvesting the puffballs from field sites. This is a constant cycle. Doing the same in Malaysia with **{??? dipocarts 038}**, China with our southern pines throughout China and also some of the native trees. Mexico. I'm getting ahead of myself now but we did research in all these countries and published it to show yes, biologically this works. Commercially, question mark, because there are no companies producing it. Four years we worked with Abbott we finally got some very good formulations from them. Legionnaire's disease hit. They shut down the firm that was producing our product and started mass-producing erythromycin and sulfate, erythromycin and phosphate for control of Legionnaire's disease. Also, they were the world's number one producers of Bacillus thuringiensis, biological control agent. I don't know if you're familiar with that.

HKS: I am aware of it, yes, but that's about it.

DM: Oh, it's been since the '70s it's been the number one biological control agents of forest insects as well as agricultural insects. Well, they've mass produced Bacillus thuringiensis, which is a bacterium, near our sediment fermentation. Frequently we were contaminated with Bacillus thuringiensis, which wiped us out. It out competed the fungus for the carbon. But long story short, we learned so much from the Abbott program, not so much the commercial production but how good our inoculum was that we produce in Athens, what it could do. About the last year of the Abbott program I gave a presentation at a meeting somewhere and there was a guy by the name of Dr. Steve Maul who worked for Sylvan Spawn, a commercial mushroom producer. And what they do with commercial mushroom spawn is they have these **{??? autoclavable 054}** plastic bags that they fill with grain and nutrients and inoculate the **{??? saplifite 055}**. The mushrooms are **{??? saplifite 055}**. Commercial mushrooms are **{??? saplifite 056}**, not mycorrhizal. So you can artificially grow it and it can complete its life cycle and produce mushrooms without a plant. It can grow in caves where it's dark. But he became interested in mycorrhizal fungi because they had developed a blender, one operation they could fill this blender up with grain and everything else, autoclave it and fill these bags up aseptically in one operation. And he said do you think that we could do that with Pisolithus. I said I don't know. We can sure try it. Because everything with Abbott was open grown, in the open. It was contaminated from the airborne stuff. Long story short, we started a co-op agreement with them. We were successful. The company that he left, the mushroom company, had formed a company called Mycorrtech, M-Y-C-O-R-R-T-E-C-H. And his primary mission in life was to produce vegetative inoculum of Pisolithus and some spore inoculum. But we did tests and many publications showing how this inoculum was equal to if not superior to that which I was producing at my institute in Athens. Everything was patterned behind what I did at that and then

we modified it as much as we could to make it practical, make it commercial and he did it. With his corporation we did it. Pretty smart guy. Well, here he is now he's got this Mycorrtech Company producing for the first time a commercially available inoculum of mycorrhizal fungus, this Pisolithus. And we were using his inoculum, rather than growing our own we were using his inoculum in some of our field tests runs because it was easier for me to pick up the phone and say, Steve, I need fifty liters of your stuff for next spring and he would do it for me. But that expanded the program quite a bit and about this time, like I said, we're giving twenty-five or thirty talks a year all over the world and more and more people are becoming aware of not that we're capable of managing a specific species of fungus in your nurseries or container nurseries, either bare root or container, but it has remarkable success on reforestation of mine sites, any hostile environment, and on routine reforestation sites. Because we're getting feedback, we got eight-year results from Great Southern Timber Company. They had a study in after eight years. It was something like an eighteen percent increase in growth. And Weyerhaeuser published a review paper on some eighteen studies we put in with them that we were actually increasing site index by six and all this, right, good stuff, very positive results coming back from Mexico and Venezuela and all these other countries by this time. Like I said, each nursery phase is one year and then we usually allow three or four years in the field so we're talking about a five-year period for every study. And, of course, you'd carry twenty-five or thirty of these a year. And so it was all coming to a head about '82, '83, '84. All these results were coming in and everything else and well, we now have company that's commercially producing the stuff, which is what we wanted. Make use of all this information. Let's fix something that's broke with all this information.

About that time the Forest Service was changing. They looked at me as now with all this capability of, I don't want this on record, the fact that I could find all this money, that we could, National Institute of Health, I had a money production. Universities, graduate student support, international foundations, Rockefeller, Ford, we could find money, USAID, OICD, INESCO, NATO. They said well, we want you to, oh, DOE. Over a period, DOE, I think they funded us like three and a half million dollars the whole time I was with the Savannah River site. Keep in mind it wasn't DOE when we started. It was Atomic Energy Commission when we started. Then it became ERDA, Energy Research, whatever, and then it became DOE, Department of Energy. That's how long we worked with them. We started off in '75. That's when we were doing the work with them and they funded us, like I said, very, very well and treated us very, very well. Basically if it was legal they gave us everything we wanted. There was no problem, lab space, analytical chemists to work with us, and nuclear scientists actually worked with us. Got pretty sharp boys.

The Savannah River site was unique. It's three hundred and fifty thousand acres of a controlled environment, highly restricted, no fly over, barricades, everything. So you could put stuff out in the field there it ain't going to be touched, and we were doing it. We were doing quite a bit of instrumentation looking for rainfall, temperatures with our field techs and we're trying to correlate all this together. Well, in 19, I guess in 1985 acid rain hit, NAPAP, National Acidic Precipitation Assessment Program. Two years before that a colleague in Germany said, Don, you got to come look at **{??? Volsturban 126}**, which is the acid rain disaster in Europe. They had funding to different places. So we went over there to look at what the situation was and it was, well, if everyone says it's acid rain, it's got to be acid rain, right? Okay, where's the scientific

proof? Had very little so there was a need for a research program to see what's causing it. So we went over there. We put in a fifty-acre spruce study where we removed the density of the spruce about one tree every twelve foot centers I guess and then we inoculated the devil out of them with Pisolithus and treated some with lime, all kinds of various things to see if we could change the acidity of the soil because everybody assumed that acid rain was causing this. Well, they had very little supporting evidence, all circumstantial. It wouldn't stand up in a court of law. They did not have a heck of a lot of normal to compare to. I mean how can you recognize abnormal if you don't know what normal is? Right? They did not have a lot of acid rain measurements in collecting rainfall. They had some and it looked pretty bad and they were going on this thing, well, the Ph in the soils is Ph 3.8, but that's normal for firs. You can go back to some of the archived literature, right, to the 1800's before the Industrial Revolution and all of the major coal burning and all that kind of stuff and the natural Ph of a spruce forest is around anywhere from 2.8 to 3.8. That's normal. So we did not have a lot of baseline to what's normal. Well, the study was successful, believe it or not. We actually improved the growth of the spruce trees by inoculating with Pisolithus and using lime. Lime by itself did so much. Pisolithus did so much. The two together it was almost synergistic. It looked pretty good. And about that time NAPAP came about in the United States and since I had my finger in that pie the Forest Service said we're going to have a southern commercial forest research component to this, thirteen states. Marx, you're in charge of the Forest Service. Ellis Cowling is in charge of state. And Jim Woodman with NACASI representing industry, three of us.

HKS: I shared an office with Jim Woodman when we were graduate students.

DM: Did you?

HKS: Yeah.

DM: We put together this three hundred-page plan of attack. But we were gathering evidence from all over the world from scientists from all over the world, what their experiences were, the research results they got, the monitoring information they had. Jim brought together the interests of industry, commercial interests. Ellis brought together the academic support, and I brought together the Forest Service and we put together that plan. We traveled all over the world meeting people, developing a strategy to address an issue that was basically unknown. The report was that we had forest survey had reported a consistent decline in growth of forest trees here in the South, which of course, can be due to many things. But the concern was is this due to acid rain and that's what generated this whole thing. Well, we put together this plan and we started then working with EPA and a lot of the state air quality boys, began to realize that there's another guy out there called ozone that might be just as bad if not worse than acid rain. Ozone, of course, is a secondary pollutant. It's formed by petrochemicals in the air. Of course, the **{??? odor 191}** of a pine tree in a forest is a petrochemical and is a source of ozone potential. The nitrogen oxides are emanating from soils and also exhaust combine in the presence of sunlight to produce 03, which is an oxygen molecule on steroids, in a sense, and it can be quite devastating to the photosynthetic process, just completely in a sense bleach out the chlorophyll, can be very, very damaging. We've known about that for, Charlie Berry worked on it in the mountains of North Carolina back in the '60s. We've known that ozone can be potentially very damaging air pollutant but the theme was, of course, acid rain because the average American wasn't a source

of acid rain. The average American was a source of ozone. It was not popular publicly, it mean it wasn't politically popular to talk about ozone. Well, we finally got ozone in the mission statement but not by name. Study the effects of acid rain, and other associated pollutants, on trees. Long story short, we ended up funding almost every forestry school in the Southeast in one faction or another by putting in open top chambers or acid rain studies, open top chambers for ozone, field studies, Duke, N.C. State, Florida, Georgia, Auburn, Stephen F. Austin. Almost anybody who wanted to work with us if they passed muster, if they were willing to conform to certain things, in order to obtain funding from us they had to conform to certain protocols. All the plants had to be mycorrhizal. I produced inoculum for all the plants because that's natural. That's the way they're supposed to be. Most of them were in containers so we put together protocol on how to do this. We actually developed large specialized containers for the plants that are commercially available in Canada now. But program was off and running. The three of us put it together. Like I said, it took about a year. I think during that year I was probably home a total of two months at the very most and all this time I'm doing the research at Athens during that same period trying to close down some things. Well, not close down but zip up things, publications.

It then became apparent first off that Ellis and Jim and I were not able to maintain this pace. I mean the Forest Service was not going to allow me to work fulltime on this thing. My job was to help these people. The three of us would put together a plan, a strategy of attack if you will, five-year plan, and then we got to hire somebody. This is where we hired from the acid rain foundation at N.C. State, just left my mind. She's now deputy director, Ann Bartuska to head up the air pollution program, and we just gave it to her. Worked with her for about six months to

make sure the handoff, you know, was okay. Let the people we met meet her and all this other stuff. So she became the manager of this big Southern commercial forest research thing. Well, along the way there were certain scientific issues or deficiencies in scientific knowledge that became very evident. Again, going back to what I said before, how can you recognize abnormal if you don't know what normal is? So we're sitting there talking about basically there are so many things that could be responsible for this growth loss and the number one priority would be water, right. Availability of water is the number one limiting factor for forest tree production worldwide. But we had in the South several good, Wayne Swank, other hydrologists that we're talking to these people and all this other stuff, you know. So okay, is it possible to put together what I called a Southern commercial forest atlas where we could get all the weather records going back to 1800? Get all the soils information from the soils people, all the tree distribution data from the dendrologists and all this other stuff, tree species, forest survey and atmospheric deposition things from EPA and all the air quality centers they have. Can we get all this and create an independent atlas for each one and then integrate them together? Are we able to go back to this atlas and recall data, information on weather, the soils, rainfall, whatever, soils, atmospheric deposition, what species there on a computer and have it translated to half degree grids, twenty-five or twenty-five square miles? We did it. We were able to integrate using Region 8 computer. Every time we turned that computer on the damn lights in Atlanta would dim. Had seventeen billion data sets, all the weather records, we krigged them, meaning that we had, this is a mining term. Let's say these were a hundred miles apart, these monitoring stations. Well, we would krig them across at different increments and what we did we would to test the kriging concept we would have data here, data here, or data here, or data here, say these are three different cities and we knew what all five of these were. Let's say rainfall on June 3, okay. Well,

we would take this out of the set and with these four could we estimate them, called kriging, grading analysis. We were able to using this instead of having data scattered all over the place we could actually have it translated into twenty-five mile pinpoints. We then got the atlas and said okay, during 1973 through 1977 there was a severe drought here in this area. Look at the rainfall records. And here on these same soils we have soils that have very poor water storage properties. Now let's locate these sites, forest survey got sites all over the place, and then find the closest forest survey plot and we'd go and run, did chronology, go back through forest survey records. Eighty-five percent of the growth loss was due to rainfall. This is off the record. It was not politically accepted. This is off the record. Like I said, the whole purpose of this thing was to prove. We were actually told prove that acid rain is damaging the forest and we refused, said no, that's not a scientific question. Scientific question is, is there evidence that or can we produce evidence that, we can go and prove. It's got to be a known hypothesis. Thing about it is we found out that the acid rain was actually stimulating tree growth because of the damn nitric acid, the nitrogen, which is a fertilizer and sulfur was a fertilizer and some of the sulfur deficiencies soils in the South. We actually increased growth in some of our field trials.

HKS: Who was pushing, DOE mainly, this hypothesis or lack of hypothesis, Forest Service?

DM: Politicians, one hundred percent politicians, anti smokestack, again, this is off record. I damn near got sued a couple of times because of my unfortunately unspoken stuff. The environmental groups were basically pushing this to such a degree, I haven't got to this point yet, is they're going to shut us down. We don't want any more trees cut. We don't want any more damn smokestacks, you know, and this other stuff and I said have you picked out the cave you're

going to live in. It was strongly driven by that, the environmental movement. And I'm not saying it was wrong. I'm basically saying we must do something about that but the techniques that they used, they destroyed some good scientists that stuck their necks out and got it cut off. We were not, to my knowledge to this day, none of this information was published, the fact that acid rain because of sulphur and nitrogen fertilization actually increased tree growth.

HKS: Very recently, the last few months, National Geographic had an article on haze.

DM: That's right.

HKS: I don't know if you looked at that.

DM: I got it right up here, yeah.

HKS: I thought it was interesting that still after the coal fire electrical people in the Ohio Valley and so forth.

DM: All right, the exception to everything I just said, again the solution to pollution is dilution. Ohio Valley is a center of all this so much of the energy, the coal burning energy plants is that the acid rain there has acidified soils apparently enough to where aluminum now is becoming toxic to some of the mycorrhizae and some of the fine roots and stuff like this. But still doesn't account for this apparent growth loss. Ozone, yeah. But see what, [hesitates] trying to be as careful as I can possibly be here because I have very strong opinions about some of this.

HKS: That's good. Let's hear them. Put them on tape.

DM: The test that we made with ozone we knew we had a pretty good idea what the ambient, on average the ambient concentration of ozone was. And we knew also that based on the data we had it took something like twenty-five, thirty, forty years for that ambient concentration to get that high, that we would go on field trials with twice that. Well, if you look at the projection it would take a hundred years for that ozone concentration to be present. And so we're testing it at unrealistically high concentrations. Just like me saying all right, you need two quarts of water a day, I'm going to give you two gallons of water a day. You'd probably drown, you know, with the extreme, and this is what we're doing. Now we've shown, there's no question about that, twice ambient or some places three times ambient ozone, no question, extremely damaging. It was the rare occasion that the ambient level showed a consistent inhibiting problem, which I think is a matter of experimental method because ozone is bad. There's no question about that. But ozone's always been here. Whenever we have odor in the forest, the smell of pine tree or spruce forest, that is a precursor to ozone. And all of our most healthiest forest soils produce nitrogen oxide as part of the natural mineralization process, emit to the atmosphere, so you have your two precursors. The third is sunlight. That's all you need. You've got ozone. So we've always had ozone. So our plants have always been able to adapt to that low concentration. Our problem is that man has just increased the concentration. Thank God I think we still have the mechanisms for most plants to adapt til we get to a point of ridiculousness and then everything is dead. Ozone is the major problem, acid rain specific locations in this country, possibility. If there's an air pollutant it's ozone and that's your smog and stuff like that.

Our problem is politically driven scientific research programs, especially in forestry, are short lived. We have a tendency to think well, I want to study the ecology of a two hundred year old forest ecosystem. I can go out and do it in three weeks. And you take a snapshot and you think that snapshot represents, it doesn't. We all know that but we can't get long term funding. My program on mycorrhiza was unique because I was permitted by some Forest Service people like Buckman, Keith Shea, to follow the wild rabbit. Get funding however you get it as long as it's legal, you know. We can't fund that level. DOE or whatever and go. We could not do that today. It would be impossible. I know projects that are worthy of that kind of stuff that will never see it. In fact, if there were certain big, in my opinion, significant achievements in the Forest Service, these long term monitoring things like Wayne Swank's Coweeta, other locations like that, ten years from now I'll be very surprised if we even have those again, if we have those, because we're going now towards the ecological rather than function. Going strongly ecological. Trees are valuable other than for a bird to sit on.

Tape 3, Side B

HKS: You were saying the Forest Service had lost or had changed its ways. Is most of that change from Congress?

DM: Yes, environmental mandate, there's no question about that. The Forest Service serves the public and if the majority of the public, if the majority of the people in this country think that this is the way the Forest Service should be doing their operational application, that's what they're

going to be doing. But I don't think that the Forest Service was given the equal opportunity to communicate our methods, best management practices, the value of the resources, renewable resource, as a hydrologic machine in a sense, that clear cutting is not bad. If you have to have an open grown tree species to reproduce itself you'd better not have too much shade on it, right? It's common biological sense. Now if you don't want all of this tree harvesting, then quit writing your letters of complaint on paper. Quit sitting in a wood framed house. Quit sitting in a wood paneled office or at a wooden desk. Our problem is that it's a renewable resource but people don't want the trees to be cut in the large part. They want it all to come from other than federal land. I'm luckily very fortunately I'm not in the position now to help make that decision. I'm very glad I'm not because it's a tough call. I remember the Forest Service returned to the U.S. Treasury after all expenses of the Forest Service, the national forests, the research arm, the state and private forestry, where we returned three hundred and fifty million dollars a year to the U.S. Treasury from allowable cut, hunting licenses, camping licenses and stuff like this. Not anymore.

HKS: The Clinton administration tried changing leadership of the Forest Service, the chief. They had two biologists, Jack Thomas and Mike Dombeck, and I just see this from a distance. Does this affect research when the chief changes to not to be a tree person but to be a biologist?

DM: Very definitely. The significant changes, first off Jack Ward was doing what he was told, what he was supposed to do. This was what he was hired to do, and he did a dang good job of what he was hired to do. Our problem was that we shifted direction away from a minor part of the forest ecosystem, shifted to a minor from the big picture that the forest is other than sites for wildlife. There are other reasons for it, other things that functions that are valuable and important

aspects of it. And during that time you saw a decrease in the activities of targeted research programs where they're trying to solve a specific problem rather than to study something. Big difference to study something ecologically than it is to address a specific problem and solve it, say like control of southern fusiform rust or something, compared to studying the overall affect of forest management on wildlife habitat or something. And I think to this day that is still a large part of what is going on.

HKS: I interviewed Mike Dombeck and he said one of the first things he did as a chief and he was over in BLM working closely with Jack Thomas and things and from the Forest Service he had a sense of what was going on before he became chief, even though he wasn't directly there for six or seven years. But he contacted the regional foresters and station directors, RF&D and asked them what they thought he ought to focus on as chief. And he said the response was a conference call and the response was overwhelmingly that research has lost its direction. That's why he reassigned Jerry Sesco as special assistant for great ideas or whatever name they gave him and he retired shortly after that.

DM: I worked with Jerry for quite a number of years.

HKS: Yeah, he was director of the station.

DM: Right.

HKS: And Jerry is still so upset. He declined to be interviewed. He was one of the people on our long list and he said he would not be interviewed by a Forest Service sponsored deal. So that's too bad, a person of his achievement carrying that bitterness with him.

DM: Well, the point that I made earlier that a lot of these political programs destroyed some damn fine scientists and Jerry, probably more of an administrator than scientist, but there are numerous examples of this. It's almost as if, can you imagine the American Medical Association to be led by politicians to say that we're going to control how the professional doctor practices his science, how the medical doctor manages his patients? We're going to come up with a program to make sure that it's environmentally sensitive and politically correct and everything else. It's unheard of. I mean look at us. We are a group of dang professionals just as much as the medical society, medical association. And to have a bunch of personal vendettas people come in and direct how we manage the hundreds of millions of acres of renewal resource, forest ecosystems we have in this country, is unheard of to allow one profession to control another profession, a professional group of environmental groups. I'm an environmentalist. I've been a conservationist since the first day I came to work on my Ph.D., conservationist. I'm not a protectionist. I mean we have to utilize whatever this world is producing for us but in such a fashion bring it back better than what it was before like we're doing with our mine land reclamation work and stuff like this here. But when one profession can control the mandate and direction of the other profession, there's something wrong here. There's something wrong. It's like us going into the medical association, medical, saying we're going to control exactly what you do here. We don't want you to do this anymore, this anymore, and this anymore because I just don't think it's right. I had, I'll get to this in a minute. I was asked to help, because of our

success with NAPAP, I was asked to get involved in global climate change and biological diversity, which I did. I mean the Forest Service needed somebody to do it so they asked me to do it. Went to a great big biological diversity meeting in Tucson. This is about 1986 or '87, sponsored by all the major environmental groups, all the big boys. And out of the graciousness of their heart they invited a couple of key scientists from the federal people. I represented the Forest Service. There was a guy from ARS and a guy from the Soil Conservation Service. That was back when it was still Soil Conservation Service and I don't know, about eight or ten others, but it was overwhelmingly driven by the environmental groups there. And I will say this. I want this on record. These people are as sincere about what they're doing as we are about our concept. They are as sincere with theirs as we are with ours. It's just a matter of opinion. I went to this meeting and I'm sitting there and it was primarily an educational program for politicians. The purpose of the meeting was to educate the political folks as to the status of biological diversity. I almost went crazy. After about the second day I said can we ask questions. They were making all these bold statements. Of course, identify yourself. So I went on record. I said I have a problem with logic here. You said we've only identified ten percent of all the life forms on this planet but yet we're losing two hundred fifty thousand species a year. How can you lose two hundred and fifty thousand species a year of something you don't know is out there? Where's the logic here? That's a scare tactic. I mean if we're going to do something here let's talk real. Scientific data, what's the best? We know extinction is a rule of the world. It always has been. Thank God we're not running up and down the street with dinosaurs, right? All of this loss of biological diversity in our managed forest, well, that's not true. The University of Georgia Institute of Ecology, which I'm a member of, has shown that in some of our managed forests we have more plant diversity than we have in natural forests because natural forests are mostly closed canopy, no

sunlight penetrating to the soil, therefore, that level of life is almost gone. Critters may pass through it looking for something else but they're not going to stay there. Now that's published information. What if you use that? Well, they didn't care for that too much.

So anyway, after that meeting I came back and approached again DOE. I said look, there's going to be tremendous challenge as to how we manage the forest here and what we need to do is get a threshold. We need to go into a biological diversity program. So DOE funded it and we created the Savannah River site. Eight projects in the southeastern station, some seventeen scientists doing research from wildlife to soils to mites to mycorrhizal fungi, all aspects of life, all strata, fish, wetlands. You could do research at the Savannah River site because it had everything in it, had all types of those things, and they funded it. We put together, one thing we did, they talk about the absence of hardwoods. Well, sure. So went into some of these bottom areas and found some ancient trees. I mean some of the most gorgeous hickories, four-foot diameter hickories, you know, shag bark hickories, and stuff like that, oaks, and collected seed from them, grew them in a nursery and we are creating orchards at the Savannah River site of these genetically original, if you will, trees selected from natural sites. DOE thought that was great. Region 8 thought it was fine and we went forward with that. To my knowledge it's still being done.

Then along came at the same time the global climate change program, so they wanted me to get involved in that. This is about the same time. You got that last page, Selena? Nineteen eighty-eight was the global climate change program so DOE was so generous with everything else so we started talking to them about global climate change research. Everything, of course, was aimed at "global warming." In 1969 I think, sometime in the late '60s, which is only twenty

years before this, George Hepting, the father of forest pathology in the southern United States, published a paper in the Annual Reviews of **{??? Fita 144}** Pathology stating that the cooling of the environment is going to have an impact on the distribution of forest tree diseases. And he addressed the issue is that the reports globally is that the world is cooling off. Now it's amazing in twenty short years, two decades later, all of a sudden it's heating up. Now here comes global climate change money and I'm talking about big money. In my opinion there is some evidence that there is a warming trend. But don't come to me and tell me that the last two hundred and fifty years the earth has increased one and a half degrees. Where in the hell were the thermometers two hundred and fifty years ago? What kind of equipment did they have to measure it two hundred years ago? What's the baseline information from sulphur dioxide? That one mountain in Hawaii, that's the only historic record we have besides some of that ice deposition, which is questionable data. I'm not saying we should not look at this, but don't scare the world with a red flag. The sky is not falling.

HKS: I've read recently, maybe it's in that National Geographic article, that science agrees that we're in a warming trees, but the lack of agreement on the cause.

DM: On the cost?

HKS: On the cause.

DM: Oh, the cause of it.

HKS: The cause is it modern naturalization that's causing it or just this is what's going to happen anyway. And it's put in the context of that allows the Bush administration, so this probably was not in the National Geographic. It wouldn't be about political probably. That the Bush administration said we need more studies to find out what's causing it because we don't want to shut down the auto industry and the petroleum industry and all these other industries. I don't know where I read that.

DM: No, it was in that article. I know the article you're talking about. I use the information myself. That the ocean collects two thirds of the excess carbon dioxide, is that the same article you're talking about?

HKS: Uh-huh.

DM: The carbon cycle, yeah. The old saying is if you're going to do something, do it on the side of caution. I don't disagree with that. I'm not saying they're wrong. I'm not saying I'm right. I'm saying we just don't know, now what are we going to do about that? Well, if you got a snake down there that you're not too sure if it's poisonous or not you're still not going to get around it probably. Common sense will tell you to get away from it. Well, we should be looking into this. I think there should be more of an expanded research program to not address political issues but scientific issues. And my first exposure to that was NAPAP. For three months we fought "a man in charge" on addressing the mission as a scientific question and when we shaped the question he refused it. He said your purpose is to prove that acid rain causes this damage. No, we can't do that. We'd be selling our scientific soul. You know, we address one of three ways. It's good, it's

bad, it's indifferent and we design research to answer all three. We just can't go and say you will prove. Here's a million dollars, a professor at Duke or something, here's a million dollars, prove acid rain kills trees. I'll get sulfuric acid right out of the jug and that'll eat that tree up in a heartbeat. Now did I prove my point? Yeah, here's your million dollars. This is what they wanted and we actually created such a scientific outcry that this guy was replaced as chairman of NAPAP and replaced with another man. I'm not going to mention his name, politician. But their job was to prove that acid rain was responsible for declining tree growth.

Now the global climate change, I put together, funded by DOE, got all these guys involved, the other project, just like the biodiversity program. Everybody was looking above ground. All the idea of global climate change, what's the effect of carbon dioxide, photosynthesis, and that and my interest was below ground. So funded by DOE at the Savannah River site we put in what we called the gutter array study where we installed gutters under the canopies of plantation pine, and intercepted rainfall and collected that, and collected the rainfall and irrigated it on other areas. And we had a plot where we didn't intercept anything. So we had a deficiency of rainfall, normal rainfall, and then more than normal rainfall, depending on how much we took off. We ran that for two years and we got so much fascinating root data, root growth, fine root development, mycorrhizal development, and tree growth and everything else. Amazing that loblolly pine with a deficiency of rainfall continues to grow fairly well but boy, with additional rainfall it takes off, and the root growth, along with everything else. So we created a large field program where we could on a large field scale duplicate the projections of global climate change because one of the biggest predictions of global climate change, whatever is causing it, is that we're going to have changes in rainfall patterns and in forestry that can be a disaster. So my purpose was to see what

effect would this rainfall have on below ground ecology, mycorrhizal fungi, the critters, root growth and development. We learned a great deal about root growth. People assumed that trees did not grow roots during this time of the year and found out that's a bunch of nonsense. Whenever there's adequate water and photosynthesis they grow roots year round. It's amazing. It's like your hair doesn't grow on Mondays and Thursdays only, right, it's a constant thing just like roots. So we learned a great deal about that. Again, the support we had from other federal agencies, the DOE, we had funding from EPA, Soil Conservation Service then. I forgot what they're called now. State and private, region, Bureau of Land Management, couple of others here somewhere, allowed us to do what we did. If we were restricted to only appropriated dollars we probably would never have left Athens as far as research and development is concerned, which is unfortunately the case in many cases. They give you the opportunity to run loose, hell, run loose, as long as there somebody there to keep you between the fences, and we always have plenty of those people. We had certain administrators that didn't like it, too much for you, wanted more control.

HKS: We'll talk about this later probably in some detail but this summary here of your life's work you talked about the courage of the Forest Service leadership in Washington to accept risk and I assumed the risk you were talking about was the chance of failure, that you really wouldn't come up with anything. But I'm beginning to think that there was a political risk. I mean that's what you're talking about.

DM: Oh, there was a political risk, yes. Buckman to this day he has my ultimate respect, like the guy. In fact, I was harassing him after reading some of the stuff he put in there and I got an email

back from him day before yesterday. He said you're a nice guy. The courage that he had sticking his neck out for us and other projects, Keith Shea, Stan Krugman in his subtle way, took political risks that were not politically correct at this time. Supporting some of the, I gave a lot of talks on reclamation. I gave a lot of talks on adverse sites and all this other stuff and I kept saying, you know, there are no irreversible damages. Look at the Great Lakes. The world-renowned ecologists, wetlands specialists, wildlife biologists, marine ecologists say that the Great Lakes are disasters. They will never be productive for hundreds of years. Nine years later they're catching salmon, right? What I'm saying is, I'm going the other way. There's nothing that's so irreversible that we, with our common sense and good biological science go into these areas and bring life back. There's no reason because we know what brings life in. Let's just recreate that. Put back what's missing. That's the whole concept of our company, for your information. Put back what's missing. Now manmade landscapes we've left a lot of stuff behind. Those things that we can bring back let's bring them back and we have been very, very successful. That concept that we're not doing so much damage that can't be repaired was the risk that they were taking because the political correct position was to be anti development, anti mining, anti this, anti this and everybody was driving around in chrome plated Cadillac's, this type of thing and all the complaints are on papers, letters, you know, written on paper and all this other stuff, living in wood framed houses and they say hey, I've got mine, don't do anymore. And this basically was the courage I think that I gave credit for that. Not just our Washington people but some of the industry people that were going against common public misconceived belief basically is what it was, misdirected. And a lot of that was environmentally politically driven. Again, I want it to be on record. I am an environmentalist. I am also a conservationist. I am not a preservationist. If we don't want anything done like that, changes, find out what cave you want to live in because

we're going to go back to it. But we can sure live a modern life today without having any permanent damage. We know how to fix things now and I think this is something we need to do. The work that we did with the Forest Service we had enough leaders in Washington that had the courage to stand up and say, hey, he's probably right. Let's go for it. We'll back them up on it. And they did.

HKS: Maybe just a month ago, not much earlier than that, the New Yorker ran a three- part article on global warming. I don't know if you look at the New Yorker.

DM: No.

HKS: I like the jokes.

DM: [Laughter] Know thy enemy, right?

HKS: I'm not really challenging what you're saying here but certainly as a historian it's sort of out of my field. But that article as well as previous stuff is that there is some point in global warming and past that point fate takes over and we can't ever go back and fix it.

DM: Right.

HKS: But you would doubt that?

DM: Well, please make sure we understand here I'm talking about irreversible damage to the soil where plants grow. Air, somebody else will have to make that call. Let's put it this way. We have done successful regeneration forestry, if you will, on sites that Mother Nature could not touch for fifty years, couldn't put a blade of grass on it, could not put a tree on it naturally by any means, shape, or form for fifty years, a biological desert. And we could go in very simply knowing what it takes to make a soil productive for tree growth, the physical, chemical, biological attributes that are required, put those back and you can grow them. It's unbelievable. So there is no excuse, bar economics, but what's the cost of doing nothing? It's one of the biggest things that people say, well, this is going to be expensive to do this. Well, okay, you've been planting these coal spores for ten years, you're averaging eighty-five percent failure. What's the cost of failure? And the cost of success is say one, two years of failure. May cost you twice as much but you're going to have success, therefore, you don't have to worry about it again. People don't factor in the cost of failure in some of this stuff. Well, I've been doing this for fifty damn years, you know, and I don't need any more help. Well, no, you don't have fifty years experience. You got one year experience fifty times because you haven't changed your way, haven't changed a thing. And this is what we're seeing in a lot of these places and they're turning it around, I'll get into later. But let's get back to this. Worked with a lot of university professors. I was a visiting professor at many universities for two and three weeks at a time and interacted with graduate students. Of course, I enjoyed doing that quite a bit. Again, it was all based on the application of Pisolithus, that one fungus, but it generated so much more from that. When I left the Forest Service, of course, '94, it was after **{??? Wally Bergen 374}** and all that but maybe preceding that I never in a million years thought I'd leave the Forest Service when I was fifty-seven years old. In fact, talked with Selina, I'll probably die here, you know. She said I'll be danged. We're going to do

other things besides this. It just too much administrative organizing these programs now. Was challenging, no question about that, but it just wasn't really what I wanted to do. I wanted to get back into the field, field research, this type of thing, getting back into the grunt, dirt level to interact with some of this other stuff, other applications, maybe on an international basis or what but I just couldn't get any support for it. Again, the Clinton administration changed a great deal of the philosophies in the Forest Service. We still had some people that shared my basically renewable resource views but they were argued down quite often, that they, you know, this is the current purpose of the forest, conform.

HKS: You're answering my question. One never knows how much this trickles down, especially in research side, because you have a long term project, when you change the president, change the secretary of agriculture and on down, what happens on the ground?

DM: Like I say, I have no greater respect for Jack Ward Thomas, all right, and I've talked to him a couple of times. I think however there was a major mistake when we did not put one of our own as chief, who had a broad comprehension of forestry, all aspects, from the economics to the practical to the wildlife, to soils, water, everything else, somebody who would understand the big picture and not one small window in it. And when we went to the biological theme I think we lost that in large part. I still look at the national forest as a resource, a renewable resource. Well, look at the fires.

HKS: Jack Thomas kept a journal and still does and I edited, it was three thousand pages when I started and it came out a couple of years ago, University of Washington Press. And in that

journal he said that it was either, the primary reason he accepted being chief was he was told by the assistant secretary, Jim Lyons, that—

Tape 4, Side A

HKS: Don Marx interview, June 20, Tape 4. I know who he is. I've never really talked to him.

DM: I have.

HKS: So that's why Jack became chief, because he was Forest Service loyalist in that sense. It would have been worse to go outside. He didn't want to be chief and he was a member of the senior executive service and all the other stuff that went along with it but I'm in no position to judge his being chief but he was put in because he was just.

DM: That's exactly the way we looked at it too.

HKS: Yeah and Jim Lyons systematically went through the deputy chiefs and got rid of them as fast as he could.

DM: As fast legally and politically as he possibly could, you're absolutely right.

HKS: And Jack prevented the, it was called transfer, of Grey Reynolds and others. But I was surprised that Sesco was ever on the line and I don't know that in the Clinton administration that

Sesco was on the line. In that same kind of line we have to move him out, it was Dombeck who did that.

DM: I don't know. When Jerry left the station I more or less lost touch. Occasionally I would be in touch with him but I don't know what basically happened after he left the station.

HKS: I remember the criticism from outsiders who collaborated with the Forest Service, a lot of them, on policies and they were critical. They said Forest Service research is more and more going where the money is and not providing leadership, and saying what do you want done, we've got some great guys here, give us the money. This was during Sesco's time. It doesn't mean any of that's true. It just means somebody told me that, that there was a lack of leadership.

DM: Well, of course, if you're not getting research funding in the field you always say it's lack of leadership. [Laughter] You rarely blame yourself. In most cases, let's put it this way, half of the projects that did not receive what they considered their fair share of funding probably didn't deserve it because they weren't very productive. They were doing the same old thing, just doing it with the left hand instead of the right hand. Those other half, other fifty percent, I wish that we could go back to the way it was when I came in this organization. Is that you put together a probable analysis to research the likelihood of something happening, plus, minus, indifferent, without the promise of five publications a year for the next ten years. Today and I'm still reviewing research grants. I review thirty a year, Selina? Millions of dollars, international, national, Science of the… What's that Swedish group?

Selina Marx (SM): Don't ask me.

DM: Doggone it I've been on it since 1978, why can't I remember it? Millions of dollars of research proposals, ninety-five percent of them and I'll put that ninety-five percent in italics, we already know the answer. All they're going to do is put numbers on it. Today our research programs are such if you cannot guarantee me success in three years, I'm going to grow a twenty-five year tree, twenty-five year old tree in three years; you're not going to get funded. So what you find is that the scientist already has half the information. He already knows what the results are going to be. When he puts together a plan to get a hundred thousand dollars a year to do research for, hundred thousand a year for two years to do research on such-and-such or such-and-such, he already knows the answer from a previous grant program. He gets this funded. Most of the studies are designed at givens that we already know that this happens. It's just a matter of I need better measurements on how much of it. I'm not saying that we don't need basic information on the molecular ratios between oxygen, carbon dioxide, and carbon fixation in energy relationships. It's not going to change anything. That basic research needs to be done. There's no question about that. It's being done at universities. I don't know if that's that type of research that the Forest Service should do. Don't know. I'd like to see a justification for that. What I think the Forest Service should be doing is looking at the rate of photosynthesis on growth and yield, canopy configuration, stuff like this here, goes back years ago. We know information on some of that. But a lot of the creativeness and inventiveness and risk taking, that's what it boils down to. I think it was Bob Dickerman, station director, Dickerman, is that his name? I think that's his name.

HKS: Yeah.

DM: He said go for it, Don. He said the worst thing that can happen is you fail. What a wonderful statement, right? The worst that can happen is you fail. But if you don't try it you'll never know if it's success. The worst can happen is you fail. What if you succeed? And I think that's basically persistence, persistence. And luckily, like I said, we were able to get support. We were able to persuade in some fashion to stay the course.

HKS: I keep asking the same question. Some of that must come from Congress. When you read the deputy chiefs interviews and we have them back to Les Harper who was deputy chief during the Eisenhower administration, the same thing in those committees, you're still trying to figure out how to plant trees. Every year you come back and ask for money how to plant trees or how to put out a fire, and Congress keeps looking for progress. You know, when are you actually going to solve this and you've been saying the same thing. I can't remember who the congressman was but you're wearing out the wood samples sliding them back and forth across the desk and during this annual testimony, and so on and so forth. So there's pressure from the funders to get your money's worth out of it.

DM: You're trying to say we need to sell a different story. I agree. What is forest management? Let's define what it is. If you've got hundreds of billions of acres of established, quote-unquote "forest," different age classes, different species, different geographic regions, different physio graphic regions, so on and so forth, two hundred and fifty different soils, and all this other stuff, all kinds of meteorological differences and everything else, how do you put together a forest

management strategy? Obviously, it's got to be real. What's the overall concept though? What is the purpose? Okay, we use the forest to capture CO2 to produce oxygen, **{??? soil release 090}** clean water, all the other functions of a forest and then we get to a source of wood resource. This country uses four thousand wood products a year. That's based on so much money. Wood means that you've got to cut a tree. Seventy-five to eighty-five percent of the wood resource goes, in the South goes to pulp and paper production and ninety-percent of that I think, I don't know the number, seventy-five or eighty percent comes off of forest products industry land, managed forests, strictly for that, just like growing corn. We're talking about twenty-four, twenty-seven year rotation, loblolly pine, slash pine, twenty-five or thirty cords per acre per year, whatever it may be, twenty-five or thirty cords with twenty-five year rotation, tremendous genetic improvement research being done on loblolly pine. Forest Service is managing "a natural ecosystem." Of course, we have plantation of the natural forest also. There should be a plan that takes into account all of that aspect of the natural forest, not just the wildlife component, not just the wetlands component, and not just those components that are of interest to the ecologists. There are other land use purposes, functional things that could be useful to people, which I think somewhere along the line we're on our food chain I think. We've lost that. One time I think the national forest produced sixty percent of the soft woods in this country and I think it's down now to fifteen percent because of the loss of allowable cut and correlated with that, this is my in a sense I will say somewhat educated, my concept theory on this is that as we changed our forest management practices on the natural forest, we increase the damage from wildfires because we looked at fire in a different way. Fire is the most valuable tool a forest manager has and we have been not managing the forest with the fire concept in mind.

HKS: Just where I live in New Mexico we can see the peaks in the Gila area, Gila National Forest that's about eighty or ninety miles away across. Well, not right now, there's four forest fires in the press. I always question the accuracy of the statements that are in the newspaper because you don't know where it came from and who edited it. But of the four fires, one is being allowed to burn because it's in the wilderness area. Well, the Forest Service really got hurt about ten or fifteen years ago. One of those fires they let burn for natural reasons burned down some homes and a few things. So I thought they were away from that. So it's complicated.

DM: The Yellowstone fire, two years after Yellowstone I went out there on vacation, deliberately on vacation to see it. It made me cry. We walked off road through standing burnt skeletons and I took some soil samples. They were sterile. Went on back, put them in a lab, couldn't find anything. They were basically sterile. This was two years after the fact. Only place we could find anything that was coming up live was some animal droppings, you know, soil sampling and some animal droppings, and basically the soil was sterile and they're sitting there advocating, the ecologists with the National Park Service saying that this is good, that it will come back, and it will become a natural ecosystem again. I said do we have a timeframe for that. Well, they wouldn't answer that, of course. Well, we just got the People's Choice Award from the Bureau of Land Management Reclamation Mining at Yellowstone. Went out there last year and the fire, large areas of the fire were still biological deserts.

HKS: One of the five scientists I'm interviewing is Dick Rothermill who worked at the fire lab in Missoula a long time. He's an engineer and he was one of spokesmen on national news every

night about the Yellowstone fire. I don't know what he's going to say about the fire but as an engineer maybe he has, you know, fire modeling is his specialty, about the biology of the fire.

[DM shows publication to HKS.]

HKS: This is what you do?

DM: No, no, that's just a very small part of the company. That's just one of our many subsidiaries, Reclamation, Ph.D. Reclamation. We'll get to that later on. But just like I said, we were at Yellowstone, that was two years ago, and driving down the Eisenhower Causeway where this site was, Rockefeller Causeway, excuse me, the burnt area, this is now twenty years.

HKS: Eighty-eight was the fire.

DM: Sixteen years, fifteen years, average size tree is about four foot tall, three foot tall. It turned out they did some aerial seeding because this wildlife, this biologist said it will come back by itself. Where in the hell is the seed source, lady? I said you've got seven thousand acres here of scalded landscape. There's not a seed source tree in this entire area. Now where in the hell is the seed going to come? You're talking about every seeded tree species, you know, spruce fir pine. It's not as if the wind is going to blow them in twenty miles away. It will all take care of itself. Mother Nature has a way to take care of itself. Well, I think, as far as I'm concerned, it's a human disaster to allow that degree of resource to be consumed in smoke. I think it's horrible. Prescribed fire I have no problem. I'm a firm believer in prescribed fire to reduce that fuel load.

But to let a wildfire go uncontrolled if it has any potential to get to the crown like it is there now, stop it and go back in with prescribed fire to reduce it. Like I said, I'm pretty sure there are fire experts out there that would disagree with me.

HKS: Have you watched at all what's happened after Mount St. Helen's eruption? It's coming back. I was flying into Portland.

DM: It's coming back because it's planted. Weyerhaeuser and who else was that, planted like a hundred and seventy million trees on that blown down area and stuff like that. We did studies on the ash. We got it shipped in, fifty pounds. Don, can you find out if this thing would support plant growth. Well, how deep is it out here, places ten feet deep. You got to find some dirt somewhere because this isn't going to do it. But Jim Trappe was involved in the reforestation with Weyerhaeuser and looking at the occurrence of mycorrhizal fungi and stuff like that. This is why Weyerhaeuser grew seedlings with mycorrhizae and replanted them back out there. They did a massive job. In fact, they received some kind of environmental award for that success. Some other company too, Weyerhaeuser and who else? I forget who the other one was but they planted a god-awful number of trees. But I've seen some recent photographs. Of course, the photographer probably picked a spot to photograph. I use Mount St. Helen's as a different example. In forty-five minutes she put into the atmosphere two hundred and fifty year supply of sulphur dioxide. One eruption she put in more sulphur dioxide than all produced by the industrial revolution worldwide. That statistic came from the Boulder lab. One forty-five minute period, a great big giant belch and put that sulphur dioxide in the air.

HKS: I had the experience of flying into Portland the day of the second eruption and we were turned back.

DM: Good for you. [Laughter]

HKS: And so I came in the day after the second eruption and it was ash about four inches deep on the runways in Portland and all that. But it was quite something.

DM: I have a conference call here at one o'clock but don't worry about that.

[Tape recorder turned off and on again.]

DM: I've got to remember what we were doing. I would like very much to spend some time tomorrow with the company to show that there's life after the Forest Service and that all this technology that we generated in the Forest Service is now being put in application, solving problems worldwide, because we're worldwide with our company now. We are publicly traded as of last year and doing extremely well. We're got some things going being executive director I can't talk about but we have some things underway right now that's going to make what we've done up to now child's play, unbelievable, unbelievable, scary. Almost as scary as the first day we started cranking up this research back in the '70s and saw what it can do. But like I said, we're agriculture production.

HKS: It's fascinating.

DM: Yeah, putting back what's missing. That's all we're doing. We know how Mother Nature does it, just trying to duplicate whatever she's done, bring back whatever natural system she's got. And that's all we're basically doing. We don't fool ourselves. We're not doing anything any more than that. There's nothing magic. We're not changing the genetic structure or anything. All we're doing is putting back what Mother Nature had out there for millions and millions of years. We now understand what role that plays now, put it back.

HKS: You'd think the environmentalists would support that. It's natural.

DM: Oh, yeah, they are.

HKS: And the concept.

DM: Yeah. Well, the only problem we have in concept is the difference between organic and natural. We're not an organic fertilizer company. We're not an organic company. We're a natural systems company. Now some of our stuff is organic, but in large part, no, we're not condemning synthetics. The damn synthetics have been feeding the world, right? We're a damn fool to condemn the chemical companies and everything else. Without them we wouldn't be able to feed ourselves. I'm totally convinced of that being a pathologist. I've seen the effects of it. We are able though to put together strategies that will allow not as much use. In fact, I can tell you this and we'll talk about this tomorrow that, are you familiar with Miracle Grow, Scott's?

HKS: Yes.

[Second day of interview begins.]

HKS: I'd like to go back to something you've talked about already because I thought it was very interesting. I was thinking about it last night. That in the past ten or twenty years the shifting emphasis towards ecosystems approach to things. And if I remember correctly you said that approach is affecting research because long term projects like what Wayne Swank is doing in Coweeta will lose their funding because that's a single topic. And this is my understanding of what you were saying. That's why I want to clarify what you were saying. How would that affect this funding?

DM: Well, there has always been long term research in the Forest Service. In many cases it goes back to the '30s where statistic was not a [tape goes off briefly]. Here in the South we had thirty or forty-year fire plots where they were doing all kinds of fire studies and everything else over a period of thirty or forty years. One of my scientists that transferred in for fifteen years of his entire career all he did was measure permanent field plots that other scientists had put in some ten years before. And he was never able to get a publication out of it because none of the studies were finished. So basically here he was making all these measurements and statistical analysis and making all these reports and everything else and for fifteen years he didn't have a publication. Well, he crashed as far as progression up the line in science so he transferred to my unit and we put him in a situation where he could start getting some research done that would net some publications. Problem with this long term is you have to redefine the role of your scientists

I think. There are some awful good scientists that were doing awful good work but you wouldn't know who they were because their name never appeared on a publication. Rarely were they invited to a symposium or whatever because they're the interim guys. You got a thirty-year study and I've got the ten to twenty-year period. No, this is true. This happened all over the place. It was primarily forest management, although there were some other disciplines that worked the same way. The biggest problem with the ecosystem approach to research is we weren't prepared for it. We did not have, in my opinion, we did not have scientists adequately trained to address trees at the ecosystem level, trees and all things in the forest at ecosystem level. In fact, I recall in this biological diversity program we worked with the DOE, it took us two years to define ecosystems. They started coming out that a rotted log is an ecosystem. Wow, boy we're really going to do some ecosystem research now, right? I'll go out and get a handful of soil with ants in it and I've got my own little ecosystem here. They were actually defining it that way. So what is rather difficult to focus I guess was a big problem. Some of the strategic plans that I saw were so broad that it was almost impossible to grab anything in the scope of these things. And they said it's all going to be a team approach. Well, we're going to bring in entomologists, pathologists, silviculturists, soils, mensurationists, and create a team. You can't do that overnight and our problem was our funding was such that they expected miraculous achievements by Friday. Not quite that exaggerated but this is what they expected because at the end of the first year they said, okay, how much progress have we made. Well, we finally introduced ourselves to everybody who's part of this team. Of course, they're scattered all over the world and all over the states. Put together the cost of bringing everyone together for the first strategy meeting, right, and it was a wonderful concept but it was one that we at the time could not get our hands around. Again, because the type of scientists that we had on board at the time were specific problem oriented

scientists. And this ecosystem level was a study to observe, to study phenomenon. It was not problem solving oriented, which is what we were, especially those of us hired after Rachel Carson. I was a Rachel Carson scientist, right?

HKS: Yeah. That's kind of interesting because earlier Forest Service research was descriptive and they threw that out and replaced it with statistical analysis and—

DM: I understand what you're saying but if you go back and look at some of the earlier work, some of the work even from Germany in the Forest Service, '20s, turn of the century, 1920s, '30s, it was this empirical type of work. You go out to observe. That's a big tree. That's a small tree, this type of thing. But, you know, if you go back and reexamine a lot of that work, which some of our scientists who put the statistics on this stuff did, they were pretty good. They were pretty accurate with a lot of their observations even though they weren't replicated experiments, this type of thing. That's one of the problems with what I call a cryptic scientist who goes out and makes physical measurements and his whole life is predicated around the analysis of those numbers and he's not an observer. Because you first should observe phenomenon before you measure it. And we can be so restricted in our tunnel of vision and say all right, this is going to be approached and I'm going to have three variables in this study. I'm going to statistically analyze them with a multiple range test and etc., etc., to see what the differences are. We have thrown away so much good information from research studies that were not significant at the five percent level. I was on editorial board of five scientific journals and one of the most frustrating things I had to do was look at some of this data, this is good stuff! Unfortunately, it's significant at the ten percent level. And I used to tell the editor I said I'm going to send you to

Vegas with a thousand dollars and give you a ninety percent chance of winning, ten percent probability of failure. But that was **{??? 367}** and we have discarded so much. So we've gone from one extreme of casual observations, this is significant, to highly restrictive numbers that if those suckers are not significant at the ninety-five percent level of confidence, you can't publish it.

HKS: My understanding is one of the scientific weaknesses of early ecology, say more than twenty-five or thirty years ago, was strictly descriptive. Go out and we see this tree and that bush and whatever it was and write a description of it. And so we've got all this and what do you do with this?

DM: What does it mean?

HKS: Switching to hard science where they developed the hypotheses if you altered the ecosystem some way, this is what would happen.

DM: Dr. Gene Odum at the University of Georgia, the father of modern day ecology, was a colleague of mine at the University of Georgia. I was one of the first scientists as a member of his Institute of Ecology at the University of Georgia. His research was done at the Savannah River site where we did a lot of our research. Where he was observing, you have to realize the Savannah River site was formed in 1952 to produce plutonium and tritium, make the bomb, five big nuclear reactors, this type of thing. Closed off, wall that sucker off, fence it off, total complete security. Well, all of a sudden they got all these lakes that they have to have to cool the

water to cool the nuclear reactors and there's a discharge of hot water and the hot water is having tremendous impact on the wetlands. So Dr. Odum was brought on board to look at what does this mean. Is this damaging the environment? You know, is this a permanent problem? Well, Gene, like I say, he's an extremely creative man. He just recently died, retired down at Hilton Head. Convinced the government to form what is now called the Savannah River Ecology Lab. It's part of the University of Georgia. And as a center of research to find out first the effect of this hot water discharge on aquatics, toads, salamanders, every life form in these areas. And they did tremendous research in there for about ten, twelve, fifteen years. And then they expanded their mission to look at other aspects of that reservation. That place is totally protected. They completely moved all the buildings from two cities. The highways, the roads, are still there and here's an old pipe sticking up from an old filling station, right, and they've got natural **{??? reconnization 423}** taking place. And he studied that succession in open field. Used to be farmers field. He started succession looking at the light seeded hardwood being blown in, the pine species being blown in, and studied the ecological succession that took place. That started ecology, that report, those reports back in the late '50s and '60s and he created the Institute of Ecology, now a center—

Tape 4, Side B

DM: If you look at these early reports there are very few physical measurements, right? They are just using general terms like this species succeeded this species, you know, and they've got so many trees per hector or acre. That's what started it all. Now the Savannah River site, like I said, we did considerable research on the Forest Service primarily reforestation and reclamation of

those barrow pits and things of this type with municipal biosolids in it. And then we started looking at biological diversity and going into the bottoms and getting some of these undisturbed. In the South the largest hardwoods are still present in the river riparian areas of rivers because they were protected from fire. Fire rarely encroached upon that area and second, rarely did they log it because it was swampy. It could get awful swampy so they couldn't get the logs out. So those areas were relatively undisturbed, relatively undisturbed. So this is where we went in looking for our **{??? germ plasm 012}** for this biological diversity program and we found some incredible areas. Now all of a sudden we're going toward, as I understand it, at first let me qualify this. I'm not absolutely sure I know what all is going on in the Forest Service right now. My finger hasn't been in that pie for a long time, even though I do discuss what's going on with certain Forest Service scientists that call me just to discuss this, this, this, how would you react to this. Last week they closed down my unit in Athens. All my people are gone. They kicked them out, early out offer, this type of thing. They shut the entire unit down. The Institute for Mycorrhizal Research and Development we, me and my staff, with permission from Washington, decided to change it to the Institute of Tree Root Biology in 1990 to expand our mission and we got permission to do this and we did. Basically nothing changed other than the fact we now have legal authority to do things that we'd already been doing anyway but we're now covered under this umbrella of trees root biology, not just mycorrhizae. And the results after I retired in '94, these guys kept on trucking. I mean tremendous impact of the research, results that they were doing, not only the biochemistry that was being done but also root morphology, work that Dr. Karmatic was doing and the disease work that Dr. **{??? Otto Sene 028}** who replaced me as project leader who was my former student. We got him out of Berkeley. Brought him back from Berkeley back to Athens to head up the project. But because the emphasis

research direction changed in the Forest Service, the problem oriented units were reevaluated and again, like I said, it's hard to get someone change if they're used to ballroom dancing to dance to jitterbugging. Right? I mean your entire professional life had been programmed towards there is a problem. I'm going to make observations on this problem. I'm going to approach it systematically and do research on it to find out what is causing that problem and is there a solution to fixing it. That's what drove us. As I understand it now, that's not the case.

HKS: So your leaving was not so much, I want this to be in your version, not mine, but I'm just trying to understand what you're saying here.

DM: You're doing good. I think you want me to say exactly that.

HKS: You retired early as it were not so much in opposition to what was going on but you just didn't want to be a part of the—

DM: Exactly. Well, I was weary of the extensive travel. The last three or four years of Forest Service I was on at least four airplanes a week. Athens it was an hour and a half drive to Atlanta airport and there's security and everything else but in and out of there and a lot of one day turnarounds to Washington and leave home at three thirty in the morning and get home at eleven o'clock at night to sleep in my own bed, you know. Putting this administrative stuff together for the biological diversity program and the global climate change and trying to restructure the unit, just extensive travel, weary, I got tired. I wasn't able to find the time to do the research that I wanted to do, that I still want to do. And the opportunity came up, we looked at everything,

Selina and I looked at everything. All the children are, of course, grown and gone somewhere and said well, this is the time to hang up and by chance we found this place. It's a long story but we found this place and bought it. We actually bought it in '93. I was retired in '93 because we were living in that guesthouse, which when we bought this place there was a tree on it. Selina and I and the kids we rebuilt the place so we could have a place to stay. Anyway, the station directors and administrators asked me not to retire, would you stay another year to help us restructure your unit, because I thought I already it restructured. I said well, I'm living down here. They said that's all right, we'll get you car and you got to still do your job because a lot of my research at the time was at the Savannah River site and it's exactly half way between here and Athens. So we could arrange to spend Monday, Tuesday, and Wednesday in the field at the Savannah River site. My technicians would drive east from Athens and I'd drive west from here and we'd meet up there about nine in the morning and work about a couple or three days and they'd go back to Athens and I'd come back here and do the writing and everything else I had to do. So we're still productive, even though my worksite basically was here. That was weary. Driving to Athens, which is a five-hour one way from here, doing that frequently one day turnaround, work four or five hours there, you know, in just one day turnaround, because we were building this house at the time.

But finally retired in January of '94 and I felt confident that I'd left behind some very competent scientists and very, very dedicated and competent technicians. That's one thing I haven't said anything about. None of this work that we've discussed, these successes we've discussed, could have been done without the commitment, the dedication, and the hard work of a technical staff that they did anything and everything we asked them to do. Billy Daniel, Jim Cunningham, Jim

Kirby, Mike Thompson, Mike Allen, those guys were incredible. We would frequently leave at four in the morning, work til dark, and get back home at midnight that night because the next day we had some work to do in our nursery or something. It's unheard of. Our problem was we got in trouble with the federal laws. I don't know what you call them. But we had other technicians complaining to the director that I was killing my people. I was overworking them to death. But see, I had them. This is all volunteer and I paid them overtime. I was one of the few projects in the Forest Service that was permitted to pay overtime with somebody else's money, DOE money. So we'd go in the field and these guys would work eight hours or they'd work twelve and they'd get time and a half for four hours and they loved it. Not only that, they loved the work. They loved working with us. I mean we're all totally committed to each other. Every spring starting in 19, Selina, what was that, 1977?

SM: Yeah, probably.

DM: We had a place at Clark Hill Reservoir, a little house trailer we bought for weekends fishing, family, and that, and for twenty, eighteen years every spring all the troops would come to my place at Clark Hill Reservoir, bring their campers and their boats. We had as many as twenty-two people, scientists that we worked with in Kentucky and Florida would come in and we'd do nothing but fish, drink beer, and tell lies, and had the most remarkable pleasure of each other's company. I mean it was incredible. And that I think in large part or at least in a significant way brought the unit closer together. In fact, we had one scientist from Clemson jokingly called and said Don, I got to do a damn study with you so I can go fishing with you, because see we didn't invite anybody who weren't collaborators or partners in our program. But

it was an incredible time. We spent three days down there and like I said, if you didn't catch fish you didn't eat.

HKS: Bob Buckman talked about that and I asked him a little bit about it and fishing was big on his list of what was important.

DM: Well, you have to read my email that I sent him about the **{??? Bigore head 105}**.

HKS: That's the story. He said just ask him about fishing. He told me to ask you about fishing and that gets you going.

DM: Well, it was my therapy. I mean two things, doesn't matter, Selina and I both know. I can hold my breath for two weeks. I can go anywhere in the world for two weeks. It doesn't make any difference what I do, where I sleep, where I'd eat or anything else. But after two weeks man I start getting pretty tough and then if I know I can come home, that's it, right? And then if I can occasionally go down and get away from everything at the lake. When I bought Bob Buckman down there, this was '93 I guess, '92 maybe, and he was always, you know, this big steelhead fisherman and all this other stuff. I said you haven't fished until you tied into a largemouth bass, because we had some hummers there like that. So we went down there, went fishing, and he wasn't unfamiliar with my fishing tackle but it wasn't his, right? And, of course, he's fishing in the back of the boat. I've got the electric motor in front and I'm fishing first. He kept saying, he said I'm fishing used water here all the time, right? Well, and this is true, a big bass rolled right next to a stump and we're fishing buzz baits, you know these surface baits that flutter. And Bob

was doing a fairly good job with that. He hadn't caught any fish and I caught two or three and I was really picking on him about that, you know. Well, he threw that buzz bait perfectly and pulled on that stuff, wham. A five-pound bass hit that sucker and that thing jumped all over and everything else and spit the bait. I said all right, you got step one down. Step two is pretty good, you know. Casting it is step one. Cast, step two is get the fish to hit it. Step three is getting it to the damn boat. And I harassed him. He finally ended up catching a couple of fish but in an email I sent him the other day I said I recall that you didn't catch any fish and I caught them all, right? He wrote back and said that's a damn lie. He said he caught all the fish. But he is a good fisherman, a joy to fish with in the boat, good man. I really enjoy him.

But that was a unifying experience for the people. You have to realize how diverse our people were, our unit was. Later on we had women, Afro-Americans, all of them come down. There was no problem with that ever in this unit. I mean like my technicians used to say, Dr. Marx treats everyone equally as bad, right? There's no prejudice. There's no room for that and no place for it. We have an objective to do. Doesn't make any difference what your skin color is, what your religion is, it has nothing to do with what we're doing. Once you leave, you walk out, that's your own job. This is our unit. This is what we do. This is a team. And if anything, I learned that in the Corp, right? You go in as a unit and you come out as a unit and we were successful in that respect. In fact, we had many people that admired us because of that; that we had decided that this is the way we're going to interact with each other. We're going to be friends but we also know what everyone's job is.

HKS: Let me ask this. You mentioned political correctness earlier. My understanding is the research arm of the Forest Service has been under substantial pressure over the years because of the inherent diversity of what you guys do to recruit minorities and women and take the pressure off the larger Forest Service that has a harder time finding people that want to live in a small town and work in the woods.

DM: Exactly right.

HKS: So you agree with that?

DM: I experienced that repeatedly because you're absolutely right. Now a point that I'd like to make here I was a project leader or a supervisor of people from 1971 through 1994. I hired one secretary. I hired one technician. And a year before I retired I hired my first scientist where I actually went out looking for specific people. Everybody else that I acquired in my unit were transferred in from closed units. My technical staff, my scientific staff, all came from closed units and then we sat there and said all right, what are you going to do here. And we put together a strategy and put everyone to work and we worked as a team. We were considered a project of rejects. I kid you not. We were considered a project of rejects.

HKS: Did you get veto power over people who were assigned to you?

DM: Oh, I'm sorry, yeah. Let's put it this way. We did not refuse anyone who wanted to transfer in because they asked to transfer to my unit.

HKS: But you knew who they work, you knew their work?

DM: I knew, yes, I knew them, not necessarily as well as you know most people but most of them, yes, I knew of their work and I knew them personally but I'd never worked with them eight hours a day or traveled with them. That's where you learn people. How much work it is to kick their butt out of bed at six thirty to go have breakfast so you can be in the field at eight o'clock or seven thirty, right? How much complaint are they going to make if you don't put them in front of a restaurant at nine o'clock at night because we're working til dark? If those guys complain about that, sorry, you got to stay home, right? Because this is the way we worked. This is the work ethic we had. The way all looked at it, because of the extensive travel, if we can work twelve hours a day instead of eight hours a day and get day one day earlier with our families, it's worth it. And this is what the commitment was. It was a hundred percent commitment of everybody. If we can work Monday through Friday eight hours a day, can we work twelve hours a day and get home Thursday night, have Friday with our family, yeah, and that's what we did.

HKS: Different kind of flex time.

DM: Pardon?

HKS: A different kind of flex time to use the jargon.

DM: Well, that's another thing, give people the opportunities to goof off. I saw that abused. People would say well, I'm going to come to work at six in the morning, right? I want to get off at three. Well, that person comes in at six in the morning there's no supervisor. There's no one there but he or she, right? Everyone else comes in at eight o'clock.

HKS: I understood because Max Peterson told me that way. It's the first time I'd heard of that concept. I was sort of the old Forest Service and that kind of stuff didn't go but he said especially people working in metropolitan areas, Washington office or San Francisco, they have to renew their driver's license. They have to do things that can only be done during a forty-hour work week. They have to do that. They have to go to the bank. And you could work in flex time, which I thought was just a variation on the old time comp time where you could work extra hours and take some time off because you had to, essentially your leave basically.

DM: I could understand that. If you're working at a job that you're basically in this building eight hours a day, that's not what we did. We spent, even the technicians, for at least a fifteen-year period our scientists and technicians rarely spent one day a week in a lab. The rest of it was either spent in our research nursery or on some of our field sites working doing sampling and measurements and stuff like that where almost constantly in the field. The only time we were really back was when the weather was so bad we couldn't get out in the field. Winter, miserable, cold, wet, snowy, this was when we were measuring all of our trees when they're dormant. This was almost every week during the winter because we would have, you look at the entire scientific staff we had, and everybody had field studies and we all worked together on them. I'm out there measuring diameters on trees of Charlie Berry's study and he's out there measuring

diameters of trees on my study. We all worked together as a unit. One of the most complimentary statements I think I ever heard about me was that we were at the Savannah River site. I had me, three Ph.D.s, and five technicians on site, plus my secretary was out there working with us. And a guy, this forest manager at Savannah River site walked out and he stood around and he says I can't identify the boss out here. What a wonderful compliment because everybody did exactly the same work. We just rotated off. Everybody could do the same job, either record data, take height measurements, root coil diameters, soil samples, everybody just rotated off and just kept on going. It was wonderful.

HKS: Well, without violating confidentiality personnel processes, when you had your annual evaluation by whoever evaluated you, was there ever any suggestion that you were over priced technician?

DM: Yeah, yeah. And you know what my answer was? Give me two more technicians, and they shut up. You're right. What else am I supposed to do all day out in the field with these people? Stand around with a clipboard in my hand? That's boring. I want to have my hands in it. I want to see what in the heck my trees are. Right? I also want to go out there and kick this rattlesnake away. Right? This is all part of it. This is a team work. In order for me to get maximum performance out of my people, I had to be a vital part of their activities every day. This is the way I looked at it, follow me, and this is the way we did it. And all the other scientists basically in most part did the same thing. Frequently, let's put it this way. Rarely unless I was tied up in some meeting somewhere or had to go to Washington to do this or acting as a project leader, we all went out working with everybody else regardless. But I could then see what they were doing

and what kind of results they were having because this was all part of the team work, the strategy of the unit. Charlie Berry's work on adverse site amendment with municipal bio solids at Copper Hill and at Savannah River site, places like this. Pioneering, earthshaking results, incredible. Glen Hatcher's work with the longleaf pine and root configuration and this type of thing all that was part of our total objective. Paul Karmatic's work with first **{??? order latter 255}** root configuration showing the effect of that of superior trees in the forest opened up a completely different genetic approach to tree physiology. That all came from observations. All right, fine, we got an observation now. Here we identified what the problem is. Let's attack it and that's what we did. And we then hired Dr. Susannah Sung who I have to admire this young lady. She's of Asian descent. She got her Ph.D. at the University of Georgia right down the road from us. We knew of her abilities. Her major professor was a co-worker of ours had worked with us before on various biochemical aspects. And I convinced Washington that we needed a biochemist. We needed somebody to start looking into the chemistry, the biochemistry of root physiology, microbiology, soil processes, and that. And so I wrote up a job description and she and three other, she and three men applied for the job. The horrible thing about it is and this is true. Of course, everything I've said so far has been true, but what's really true about it is that several recent Ph.D.s that I knew, one of them was my student in Florida, said I need not apply because I'm a white man. That was the reputation. If it's a Forest Service vacancy, forget it. If you're a white guy, you need not apply. Well, she got word that she was going to be hired because she's a minority and a female and she came in. This is a little bitty Chinese girl. I'm a pretty good size guy. She walked in and she said I want you to know something, Dr. Marx. If you hire me because I'm an Asian female, I won't take the job. If I can't get this job because of my qualifications I don't want it. And I damn near kissed her because I'd already made the

selection. She was it. She was so superior in qualifications from everybody else. I said you got the job because you're qualified. I don't care what your damn nationality is or what sex you are or anything else. That has nothing to do with it. Are you qualified to do the job, and you are, you got the job.

HKS: At Duke the School of Environment faculty they hired a Hispanic woman, Ph.D. from Harvard in economics and she was going to do research in economics at the School of Environment. And she was so angry. She said the only reason they hired me is because I'm a Hispanic woman. Said a Harvard Ph.D., that didn't.

DM: Do you know how horrible that is for them? What we have created for them in their mind is that they always wonder did I get the job because of my academic and experience, or is it because I just happened to be born a certain way. It's horrible.

HKS: Tough transition. I don't know how when the transition will be over but.

DM: Well, that and among other things, I found it very difficult to have to deal with rigidly defined social issues when in the course of my life I had already defined social issues on how I deal with people. Like my tech used to say, he treats everybody equally as bad, no prejudice whatsoever. But when you have to, I'm going to give you one example. Dr. Ed Cordell, our colleague, our collaborator on all this stuff, hired a female technician. He had to have a technician to help us so this young female technician by mandate, she could not leave the motel before eight o'clock in the morning and she had to be back to the motel by five o'clock that

afternoon. That was her work hours. That's not the way we worked. So what we did, the first day we did that and my technicians were complaining. Everyone was complaining. They said we got to spend another extra day here because of the work hours. So the first day we'd made enough measurements that we could leave them with her the next day so she could work in a motel room by herself for eight hours averaging numbers and stuff like this, redrawing maps and stuff like that. We found work for her to do. She occupied a seat in the car driving back and forth. She performed basically no services. She was a victim and she felt like it. She said I want to be able to work with you in the field. She wanted to work. I said I'm sorry; we've got a mandate. We've got orders from above that you cannot leave the motel room before I think it was seven-thirty and you got to be back by five o'clock. That's your workday. Now it was two hours driving from the motel to the job site. That reduced productivity dramatically but the purpose was not at that time research productivity. It was social—

HKS: When Jack Thomas was chief he wrote in his journals that he thought he came to Washington to work on the great conservation issues and the secretary of agriculture said your most important job is affirmative action.

DM: Exactly right.

HKS: And he said we wind up compromising conservation issues in order to comply with a solution to social issues. And it bothered him a lot.

DM: When I was in Washington I heard Colin Powell who was then General Colin Powell make a statement. To this day, I'm going to have to paraphrase it, it was one of the most significant statements I think I've ever heard a significant black man make. If we spend all of our time looking for differences among us, will there be enough time left to address those issues we have in common? What a brilliant statement, and unfortunately at that time the reverse was driving this country. That we spent all of our time looking for well, they're different than us, you know, we got to do it this way, this way. We got to recognize and respect the differences. Of course, we do. But there comes a time, like in the Marine Corp, you put on that doggone marine green, you're all Marines. And it doesn't make any difference what your gender is, what your doggone nationality is, what your religion is, how big or small you are, you are a Marine, and that has been with me all my life. We work as a team. That's the most successful way of doing business when you work as a team. Once the day's job is done, go home and do what you want to do, right? If you're a Muslim, pray to that god. If you're Jewish, do whatever you want. But during this time we are a team where we recognize one thing, and basically in general we're talking about we're Americans and we work as such. Now when you get off work during the day if you want to go home and dress a different way, fine. That's your job. That's your business. It's not mine. But when you come here this allocated time is called performance and that's what you're getting paid to do. And we're being fortunate, we're lucky that we got the jobs that we had. That's was another thing, people complaining about the jobs they had. I was on an airplane flying to Montana or some place last fall, job work. Left here like four o'clock in the morning to catch that six-thirty flight out of Savannah to Atlanta. From there you can go anywhere in the world. Sitting next to a very attractive young woman, right? She had her laptop and all this other stuff and I'm sitting there reading my book and she's cussing to herself, mumbling. You talking

to me, I said because I'm half deaf, if you are you got to speak up. She said no, I just got this job, [mumbling], I mean going on and on. Supposed to be making eighty thousand dollars a year and only making fifty thousand dollars a year and all this other stuff. And it got to a point that I got so irritated with her. I said ma'am, did you wake up with a pulse this morning. Well, she said, of course. I said do you have any idea how many people in this world didn't. You woke up to a brand new day that no one's ever experienced before. Look at your opportunities and you're sitting there complaining about what's happening. Look at your opportunities here. Throw the bad stuff away and work with the good stuff. And she just sat there and stared at me and she said you know, I never thought about it that way. Because you've got so much good stuff that you complain when there's a small thing that's bad, right? And that's what's eating this country up. We take everything for granted that we get, right? So automatically that power is on there to warn you to flip the switch. You go to a store there's food on the shelves. You ever been to a country where there's no food on the shelves, where you walk into a store and there's—

Tape 5, Side A

HKS: Don Marx interview, June 21, 2005, Tape 5. You mentioned in the context of a larger issue you contacted Washington for permission.

DM: Or the station director.

HKS: I was going to say, what happened to the station director, did you?

DM: No, I always went through the chain of command. I was well trained, okay. I went through my AD, my station director, and then frequently they said well, you know, if Washington will go along with it, we'll go along with it. I always, I never bypassed leadership in the station because I wanted them to be players also. I wanted them to be supportive of what we were doing and be aware of what we were doing. I was, what's the word I'm looking for, confident enough I guess in what we were attempting to do is that once they became aware of it they would approve it. And fortunately in most cases that was true.

HKS: When a guy like Buckman comes to town does the station director come along?

DM: Oh, yeah.

HKS: So it's not a one-on-one you and Bob Buckman?

DM: Oh, yeah. We've had one-on-one in the evenings. Frequently Bob would come in with the director and the director would go somewhere else to talk to somebody else and Bob and I could talk privately. But when Buckman was deputy director, granted my memory has gone to hell, I don't recall any major confrontations against purpose in research because when he was deputy director we had a pretty good aim to what our mission was, what we were supposed to be doing. Now that was our unit. I can't speak of the other units. I know there were some problem units in the station and this is how we obtained people. For example, Eldon Ross, who eventually ended up in Washington, a very significant position in Washington, was a scientist in Athens right down the hall from me working on Annosus root rot. And Jim Cunningham was his technician

and they did some excellent work together and then when he got to a point where the "problem" was solved, he transferred out, eventually became station director and I acquired his technician. Of course, Eldon ended up going almost all the way to the top in Washington til his retirement about '92 I guess it was, a couple of years before I did. But he was a very quiet, unassuming individual, smart as a whip, scientifically and person wise, very capable. I enjoyed working with Eldon and he's also a damn good fisherman. We used to fish together quiet a bit. It's amazing how much you can find out about somebody in a fishing boat, especially when you got the keys to the boat.

HKS: I was surprised, I think it was Dombeck told me, that Peter Roussopoulos, that's not quite what his name was but it's close to that—

DM: Roussopoulos.

HKS: Was on a short list for chief.

DM: Pete the Greek?

HKS: Yeah and I thought that's interesting it come out of a station director to being on a list for chief because you supposedly have a primed and seasoned in the Washington office.

DM: Well, you got to have chain of command. You've got to be whipping boys, those who do the whipping.

HKS: That's right. I met him once. I know nothing about him other than I can't pronounce his name very well.

DM: Pete Roussopoulos.

HKS: Roussopoulos?

DM: Yeah. I like him. I would not have his job for a million dollars a year because I'm totally convinced, and you can write this, you can print this, that he has had to make decisions that were mandated by policy that he was opposed to. Well, that's what leadership is, isn't it though?

HKS: Is he still?

DM: He's still station director.

HKS: He's been there quite a while then.

DM: Oh Lord, he's been there for my guess at least fifteen years, which is probably the longest tenure of a station director I've ever heard of. He preceded, he followed Lamar Beasly who was prime chief property and they ended up making him station director here in Asheville.

HKS: What kind of decisions did he make that he was opposed to? I'm not surprised because I assume that's—

DM: Well, let me define that. Leadership is making the tough decisions and frequently it may not be your personal choice to make that decision but because of other issues you have to make that decision, and that's tough. And I think this is what today because of all the social correctness and with all the people looking over your shoulder doing this, doing this, doing this, and way down the pecking order, and oh, by the way, did you do any research. Did you solve any problems in forestry? Do we have a healthier forest now because of you were here? Those are the questions see that we eventually have to ask, isn't it? Are the forests today better, however you want to define better, because you were here for thirty-five years or whatever doing your job as you defined it and others defined it for you? And until you can answer that question you honestly don't know if you've had a productive career because somebody else defines your success. You can't define it. Others decide whether or not you're successful now.

HKS: I asked chiefs Peterson, Robertson, Dombeck, and Associate Chief George Leonard, are the forest better off for all of this what's been going on in terms of hiring different kinds of people, even though I'm fully in favor and it's long overdue and dealing with injustice and the rest of it, are the forests better off. Each of them said yes. I said how can that be. I mean how do you define, and to me I'm skeptical anyway so that probably influenced what I heard them say.

DM: You're not skeptical.

HKS: They didn't make their point that the forest. I said how are decisions better made if someone's a wheelchair when they make, on this team that makes the decisions, even though society is better off employing people with skills and so on. And I was never satisfied and I didn't want to beat it to death. The guy answered my question and you make decisions. How far do you work on someone—

DM: My answer to that is thank goodness nature has given forest ecosystems many, many redundancies. In spite of our lack of proper activity they're still surviving and still functioning. Thank God for redundancies because that's what we're basically dealing with. Look at the fires and everything else. Thank God for recovery from fire. Of course, we could speed that along but that takes money. It boils down to how we're going to spend the money. I learned that with this company, how we're going to direct the money, how we're going to spend it, on what. My disappointment I guess in myself is I consider myself a team player but I retired when Selina and I decided that I don't know if I want to be a member of that team anymore. It's time to leave. The team is going to be here. It's time to me to walk out the door. And up until I retired I never had a question like that before. I never asked myself that question. Is this team functional? Are we doing what we should be doing? Are we doing, when I was in the Forest Service I worked for two hundred and fifty million shareholders, every damn American in this country. I did not look at it from the southeastern station point of view or the Forest Service or anything else like this. My job was to answer answerable questions, research on forest health issues. Now some of this work took me to the Amazon, Liberia, China, Southeast, South Carolina, all over the world, but by definition this is the approach that we took. We got authority to do it and to answer the questions we set out to answer and we were successful at that. Then it got to a point that that no

longer was possible. And like I said, I no longer felt like I wanted to be part of that team anymore because the team was not, in my opinion, going in the wrong direction, going in the right direction. There's an old saying, you know, that I'm successful because I'm on the shoulders of the giants who preceded me. Well, that's true, but are you sure that you're going in the direction that you want to go because the giant's going to lead you where he wants to go. Right? Sometimes it's not necessarily that direction but you have the opportunity. In the NAPAP program I had the opportunity to work with some very, very smart, well-trained, highly recognized university professors. One night over beer, I'm not going to say who this professor was, made the comment to me was, what you got to do in the Forest Service, Don, is to make everybody aware that once you got your Ph.D. from N.C. State you didn't go get a lobotomy, that you're still a highly qualified scientist just like us academics are. But because you're Forest Service and you've got all these issues you have to address, you're not able to perform as a scientist as we are. And he was absolutely correct because we were viewed by Congress, now this is my personal opinion, viewed by Congress in that if we're not university professors, we're the fox in the hen house. We will sing the praises of whatever the current administration, what music they play.

HKS: I thought the academics were the ones with the bad reputation in Congress because they were for hire or anyone with a few bucks could hire a professor to prove them right.

DM: Uh-huh, but they also guaranteed I'm going to show you the results for a twenty-year study in three years. The problem is society and our political structure forced university professors and us into publish or perish. I'll give you an example. We reviewed research proposals, Jim

Woodman, Ellis Cowling, and I, we reviewed millions of dollars worth of research proposals from every major forestry school in the United States. And it was amazing those professors that had been successful in the past at getting grants, the way they wrote their grant proposals, compared to some young scientist just out of school who was probably more capable than anybody by the job description, the promises they made. This is our mission. These are the research questions that we're going to address, and here's the timeframe. By this date we'll have this answer. By this date we'll have this answer. By this date we'll have this answer. I wrote one guy back and I said write the paper. You've already told us what's going to happen. Obviously we don't need to do research on this. You have already packaged the results, that by September of next year you're going to have the results of this, this, this, this, right? And they would usually get the grant. Of course, they did not get the results that the results that they expected but they sure as hell got the grant and they came up with all these beautiful reasons why we did not anticipate such-and-such.

HKS: I can understand someone doing work in a greenhouse where you sort of control the environment—

DM: Oh, yes.

HKS: But out in the field.

DM: No, this is open top chambers. We put together, it was going to take one usually six months to build, physically build, bring plumbing, power, and all this to these remote forest areas to put

these open top chambers in where we could control ozone and acid rain and all this other stuff, and have an open growing environment where trees could grow. There was not a lot of precedent to that. What we got was out of Scandinavia where they had set up some of that stuff years ago so we traveled over there and looked at their stuff and everything else. It had inherent problems. We came back here and this is the design we want. It took eighteen months to create these. And here comes Congress. You've had funding for two years. You haven't produced any damn thing yet. Well, actually that created an environment. Well, we've got to find something quick to go out there so we can give these instant research studies, and it created chaos, until the results from the open top chambers took three years. But we had Oakridge Labs involved in it, some very, very capable scientists at Oakridge National Laboratory up there in Tennessee. It was a pleasure working with these people. They were single minded. They had an objective. They were problem oriented and all this other stuff, and of course, there were also ecologists that were working with them. The first reports that we were getting in from the annual results were not as hoped for. You know, it's a helluva note when you got results that you anticipate. That's not the nature of science. It's not the nature of research. It's either yes, no, or maybe. I mean it's a nul hypothesis approach. You study it just to see what happens, whatever the reaction will be. Well, we basically had a target. It was proved that acid rain is damaging the southern commercial forest and other associated pollutants. Well, that's not the biggest problem that Dr. Cowling and Woodman and I had was putting together a scientific question in that. How do we address this, you know. This is what they're mandating from us, right? We're basically setting out to study the reaction of vegetation in that. It created a problem but there was so much money there that all the universities and all the Forest Service projects were wanting a piece of the action, because they all had good ideas. They all could contribute to helping solve the problem. But it was not

addressed at an ecosystem level. I forgot who it was that told us, you know, that even the most complex ecosystem starts with one tree and we have to start addressing this as individual trees and then we start looking at multiple trees and species and then species complexes and age class complexes. We made a list one day. We had a facilitator came in. He brought a flip chart with about fifty pages on it and he ran out of pages, of issues that should be addressed from an ecological perspective on an individual tree basis. He looked around and he said I don't know what you guys are doing. This is the most impossible job in the world. How many forest ecosystems do we have in the United States? How many physiographic regions do we have? How many different soil types do we have? How many tree species do we have? And we're going to approach this in a five-year program? The idea was we'll dump enough money on it, we'll find something.

HKS: The Manhattan project for ecology I guess.

DM: Well see, thank God that wasn't addressed as an ecosystem. It was a single problem approach, right?

HKS: Right. Put enough money on it and enough people. Let's talk a little bit more about the Forest Service scientist versus the university scientist. I can't remember who told me. It may have been Bob Buckman. It was somebody who ought to have known, had reason for an opinion; that the problem with university colleagues is that their primary role is to train, as a scientist, train graduate students.

DM: Hopefully that's their purpose.

HKS: Pardon me?

DM: Hopefully that's their purpose.

HKS: And by definition the ten-year graduate student in short it's difficult to find interest on campuses for a long-term project.

DM: Exactly right.

HKS: Because these guys every two or three years are changing all—

DM: There's no question. In fact, it's true to day just as it was back in the '70s, absolutely true. I was on graduate faculty at several universities in the United States and also abroad and had graduate students, master's and Ph.D. students at all these locations. I think I finished up with like thirty-five of them or something like that. And you're absolutely right. The tenure of a consistent research program is the life of the graduate student. Master's students, some of them only a year and a Ph.D., two years of research usually in the three-year program because you had the academic program and then you got your research. And then trying to get a university professor to continually get funding to grow to build more blocks on top of this wall he's building, this research approach to a specific bigger element, very difficult to do because funding is usually not that available for that. So you're right. The university approach is usually two to

three years or one to three years through a graduate student. In fact, this has become more apparent now with our company because we're having universities do research for us and it's turned down a lot of it. I want this professor to do it and I don't want you go out finding someone who's going to do your, I don't mind you having an assistant but you're the one that's going to be in charge of this project and that's not usually the way they work, because they're out there constantly looking for research funds.

I guess it was about 1980. I'm not going to say what university this was, but I was on graduate faculty. We were reviewing a graduate student's progress and it came up, you know, that well, he's got to graduate because we don't have any money. We've spent all the money in this proposal, in this project we got funded. So he has to finish up. I said but he hasn't accomplished anything. Well, that's not necessarily his problem. Are you saying there's no more room for him in this department? He said basically yeah, we have to make room for the other students that are coming in who got funded. So it was like an assembly line. They were just cranking this guy out. Well, this guy who finished up with a master's found out he wasn't qualified to go hardly anywhere for a Ph.D. program, which is what he wanted to do. So he ended up going out and working somewhere at the master's level, but he was a very capable young man. But what it was is like an assembly line. He was going to be there for eighteen months. He had an assistantship or some kind of a scholarship, some kind of fund to pay him his stipend for eighteen months or whatever it was and once that eighteen months stipend was gone you'd better be through. The race better be over. You'd better cross the finish line as far as your research accomplishment is concerned and a lot of times that wasn't the case. And that's unfortunate. That's the way the system is working. The university professor is spending half of his time looking for money. So

was mine. This weary about international travel, one of the reasons I retired, we could not get permanent funding from Washington. It just wasn't allocated from Congress, right? There was a reduction in forest going on and everything else and nearly all of the appropriated funding to my unit I earmarked for salaries. And I went out and found the soft money to pay for the actual research. And I was lucky enough to be able to do that because the work that we were doing was recognized enough by people who were willing to fund it. I was no different from a university professor in that respect.

HKS: I brought this up because go back ten minutes when this university prof was saying we can do better work than you can because have all the issues to deal with, and I would have reversed it myself until you said that. I guess everyone has their own kinds of issues. Their issue was the graduate student assembly line.

DM: All I know is that the vast majority of meetings that I went to, high level meetings on global climate change, biological diversity, air pollution, etc., that the university professors were held in greater esteem just because they're associated with a university than us federal boys. I was under the impression that we were so driven by policy that independent thought and action was second. It wasn't my case, of course. My problem was I was a weirdo. I was a Peck's Bad Boy. That was my reputation. In fact, I don't necessarily want this on record but often I would make decisions that if it didn't upset certain people in Washington I obviously made the wrong damn decision because of the way things were going. This can be off the record too. I had an inspection by the civil rights group out of Washington. I sent my technician to the Atlanta airport in a Forest Service vehicle to pick them up. He refused to get into the Forest Service car because it was a

white guy. It was a black guy. He rented a car and followed my technician back to make sure he got back to my lab. When my technician came in he was so upset he was damn near crying. He said that man said he wouldn't ride with me because I'm a white man. This is a civil rights guy. Comes in, big black guy, looked like a linebacker for Green Bay. Must have been three hundred and ten pounds. Didn't seem to be very soft either, you know. Walked in and sat down and looked at me. Didn't say good morning, didn't say, he looked at me and he said you're all white. Yes, I am from the top of my head to the bottom of my feet. What the hell you talking about? He said you don't have any black people, any Afro-Americans in your project. I said you're absolutely right. He said why. I said because I haven't been able to hire anybody for fifteen years. He said that's no excuse. I said whoa, whoa, whoa. It's not an excuse. It's called reality. If you cannot hire anybody how am I supposed to find somebody to work for me who's Afro-American. He said that's not an acceptable excuse. Be creative. You need to go out and get some black people working in your unit. I said I'll tell you what. You find me the money. I got fifteen black guys qualified that are dying to come to work for me if you'll give me the money to pay their salary. I said you've got the money. Not for this we don't have the money. He got back the Washington and filed a goddamned report on me that you wouldn't believe. Redneck was the term, redneck. If I had met that son-of-a-bitch again I'd deck him. But that was the thing that was going on at the time.

HKS: Jack Thomas calls it civil rights mafia.

DM: There's no question about it, heavy handed. They immediately try to put you on the defensive. First off, I can't be intimidated. I learned a long time ago you can't live with yourself

if you get intimidated and I refused to be intimidated by this guy. I kept telling him give me the money. Don't give me your bullshit. Write me a check. Give me some money and I'll hire fifteen black guys. There's all kinds of qualified blacks here in this community, university here. Now whether or not they want to go back in the woods and work I don't know because all of our work is out in the woods. I said there's some qualified. I ended up getting a couple of black technicians and then we had a dang rift. Last hire, first fire, but I found them positions elsewhere, right? But we were victims of the policy that came trickling down, right? Reagan, the trickle down economy, well, we had trickle down social issues that did nobody any good. We created victims in some of these programs that these people actually when they got back and looked at what we had created for them, they were horrified. They were not gratified. And that's horrible that we could allow it to progress. When I hired Dr. Sung, a Ph.D. in biochemistry, I got a letter from one of the civil rights guys saying that what you should do, this is before I hired her, didn't know I hired a minority, you should go to Tuskegee, which by the way, I gave about fifteen lectures at Tuskegee Institute. You should go there, identify a qualified Afro-American at the B.S. level. Bring them to the University of Georgia and give them a master's degree and a Ph.D. degree and eventually make him qualified to work for the Forest Service. I said you're talking about five years, right? Yeah. Well, if I could wait to fill this position for five years, why would I need to fill it? I mean I am not into social issues here. My job is to do this. It's the university's job to graduate them and once they graduate them, I'll hire them, right? The university is not going out recruiting them, right? We hire from the universities. We are not the university of the Forest Service, even though we do have students under our tenure, I mean working with us in our research programs. There's no question about that. But we don't do out and do the educating. I

mean we basically handle the research aspect of their master's or Ph.D. and the university handles their academic aspects. So it was, like I said, all of this came to a head.

HKS: Let me as a question that's of interest of me because of my observations of it. I'm not a technical person. I left forestry and went for a Ph.D. in history. For the last thirty-five years I've been a historian, not a forester, as far as I'm concerned. But I've watched computers come along and be adopted and I don't know how much data analysis that you do, the numbers of such quantity that you really need a computer but now they're convenient. They weren't in the old days. You had punch cards and all that.

DM: From Texas Instruments.

HKS: My observation was people began organizing their research around the use of computers.

DM: Absolutely.

HKS: And the numbers that they crunched were numbers that the computer could handle, not necessarily the numbers that were significant to—

DM: Absolutely.

HKS: So my observation—

DM: Absolutely. I have seen scientists that would go out in the field one day and get fifty numbers and come back and spend two months looking at how they can analyze these numbers. It reminds me of somebody gets a new car. He's got three cars in the driveway that he's been driving for years but that new car, he's going to drive that sucker every doggone time he gets a chance. Now I've got a new computer here. I'm going to work this thing, man, til it screams and hollers, but you're still evaluating the same numbers and everything else. We had a scientist who had a special machine.

Tape 5, Side B

HKS: Okay, spores in the air.

DM: He would design experiments just to use this machine instead of the other way around. This machine was driving him rather than the machine being a tool in order for him to accomplish his objectives. It was a toy. And it was fun working with, a very amazing little gadget. In fact, I used it a couple of time to measure spores myself. But I could see just how easily this thing could dominate your life. You know, it was just like playing poker, right? But you're right, yes. There's no question that people must be computer literate today. I'm not. I did learn how to turn this laptop on. She does my computer work. I don't have time at this stage to address that.

In the Forest Service, when I was in the Forest Service we had an editorial staff in Asheville that had a statistical staff support that did a great amount, did almost all of my statistical analysis and I'm talking about reams and reams and reams of data. Eventually some of them came to Athens

so it was very convenient for us that it was not unusual to go in with two million sets of numbers because some of the field work we had and these guys would analyze it for us, fantastic. Of course, we had to interpret the results. They just gave us a list of numbers and the significance of these numbers and it was our job to interpret it scientifically. That was a tremendous asset for us because before that I'd usually find some university guy to work with me on statistics and trying to do it myself and everything else. I'm pretty good with math but I don't think I should be occupying that much of my time with that. There are other things I should be doing. But you're right. Now with the convenience of the expanded DG, when I was with the Forest Service I didn't even have a workplace with a computer in my office. No one did, just the secretary did. And now with the emails, personal, there are so many reasons because of the convenience of everything now, there are so many reasons not to do your job. I have walked in on many secretaries playing solitaire on the computer. Well, years ago they may be painting their fingernails. But I think we have created so many, the cell phone.

HKS: I know a guy in the Washington office he told me that he would get as many as two hundred emails a day. He said I can't even read two hundred a day let alone respond to them and do any work. And how do you sort through them?

DM: Right. I was trying to remember our station editor Bob Biesterfelt, wonderful guy, hellacious journalist, and we were at a meeting, at a station meeting and after all the rigmarole going back and forth and everything else, you know, DG memos back and forth and all this sort of stuff, and he said it got to a point that if he spent all this time reading the memos he got he wouldn't have time to write any himself. That's exactly what it was. You could spend all of your

time, every morning you come boy, this is wonderful, I've got thirty-five emails I could read, right? And the next thing you know it's coffee break time. Then after coffee break said well I've got to answer ten of these. By the time you get through with that it's lunchtime. So you get through with lunch and everything else here's a whole new series of emails. Well, the phone starts ringing. You haven't accomplished a damn thing. Original.

HKS: Mike Dombeck said, I don't if he really saw it as a problem but it certainly was an issue when he was chief. He said you got out of a chief and staff morning, which they had every morning, he said before any official notice could go out to the field there were seven email messages went out with various interpretations of what the chief decided they ought to do. It was just a big rumor factory.

DM: Oh, yeah.

HKS: Not that people were making the things up but you hear a conversation, I hear the same conversation, and we pick up different parts of it, you know.

DM: Well, you have to realize I left the Forest Service before the computer was the significant driving force. It was still the DG, which we felt was amazing because I could communicate with a field unit in Alabama without picking up the phone and calling them or writing them a letter or sending them a fax. Pete, when I retired we moved down here and we put together this company. Selina said we've got to buy a fax machine. What the hell do we want with a fax machine, we got a telephone? Well, all of a sudden it became indispensable once we got the fax machine.

Then all of a sudden here comes emails. Realize all this is within ten years this is happening. Got the computer. She had never had a computer in her life. She trained herself and everything else. And the next thing you know email is driving the world. So we got a fax, email, and a telephone. Well, we're now video conferencing. I'm not too sure, Pete, I want to look at you when I'm talking to you on the phone, right? Might look at you and say you didn't brush your damn hair; you didn't brush your teeth, right? Who the hell wants to look at you necessarily? Oh, no, you've got to prove that you are who you are. I said okay, what do you want me to do, pull out my driver's license. It's stupid and ridiculous what's going on. I'm not saying we should go back to the old ways, no way in hell, because it was not that good. There are so many ways available not to do your job. It's just so easy, the distractions I guess. The cell phone, when my barber is cutting my hair and his cell phone rang I said, John, don't you answer that damn thing until you get through cutting my hair. He said, Don, I wouldn't insult you by answering that thing. He said because I've got a job to do. Thank God, I almost kissed the younger guy. Go into a drug store talk to a pharmacist or to somebody doing this, this, this, their mama's calling on their cell phone or their daughter's calling on their cell phone or something like this. Almost everybody is walking around with a cell phone hanging off their ear. In fact, I returned from Italy where everybody has two cell phones I think, and I didn't. I told Selina I said when I get home, I talked to her on the phone, I said I'm going to go out and get me a little piece of lumber and I'm going to paint it black and put red dots on it and I'm going to walk around with that thing on my ear and no one will know the damn difference because everybody is using them. It's now become indispensable. Ninety percent of our sales force does business through the cell phone instead of their home office phone because they're on the road. It's a wonderful tool but like everything else it has its place for usefulness.

HKS: These ads make me realize I got out in time. The cell phones were just coming out when I gave up fulltime work. These ads say—

DM: Honest work you mean.

HKS: You'll never be out of touch with your office. Twenty-four seven you can be in touch with your office.

DM: And that's good?

HKS: That was good. The guys were smiling. I'm never out of touch with my office, ever. Boy, anyway.

DM: Well, one of the disadvantages of having your office in your home is exactly that because we are a multi national company now. We're up to eight time zones and sometimes if there's an emergency they don't care about the time zones. You work with what you have to do.

HKS: Or they don't know how to count. They don't know if you're ahead or behind them.

DM: Well, the worst was Australia when we had some individuals that we were working with in Australia. It was really, because we would in turn wake them up at two o'clock in the morning, right? [Laughter] But no, it's different, but I've always had a policy even when I was in the

Forest Service, I had an open door policy. I never closed the door, right? Now I would like very much if you've got something that's really going to take some time that you said Don, are you free for an hour, you know, come and ask. But here we have the same philosophy. We never not answer the phone. I mean at five o'clock in the afternoon we have a business line. I mean we do not not answer the phone after five o'clock. Hell, last night we had three calls after nine o'clock. Open door policy, this is the way this company is run. We run this company exactly the way we ran the Forest Service projects, same attitude. And the men and women we've got working for us are just as dedicated to this company as the people in the Forest Service were dedicated when I worked for them, incredible. We've been able to recruit the right people. Now we got rid of some.

HKS: Maybe we ought to get back to your list. We got two hours and you've got some things you wanted to.

DM: Well, not necessarily. I can give you this and you can just make it up as you go.

HKS: Okay.

DM: Where did we leave off yesterday? I talked about Liberia and the military coup and that.

HKS: Yes, right.

DM: Big program, all right, we did studies in Venezuela, Canada, the Philippines, Guam, Mexico, Morocco, Thailand, Germany, Senegal, Brazil, Taiwan, Ghana, Nigeria, India, Pakistan, etc., etc., etc. And the primary purpose in doing this again was training. One thing I didn't mention. In 19, I guess it was about 1975, '76 I was asked to be a scientific advisor for the International Science Foundation in Sweden. Their purpose is to find young scientists, male and female, in Third World countries that can be trained in areas that the results would be an advantage for the country. And they asked me to put together a mycorrhizal package in forest regeneration, fuel wood program, this type of thing, anything to grow trees where they normally don't grow. Well, I'm very happy to say that I'm still doing that to this day. We review five a year, Selina, International Foundation? At one time it was more than that. For young scientists who were in places that it's difficult to get anything funded or anything else and the International Foundation for Science will allocate up to ten thousand dollars a year and so we review these. And I always become part of them. Back when I was Forest Service we would bring these scientists to Athens funded by the International Foundation for Science. Part of the money that they got was to spend two weeks in Athens with the mycorrhizal institute people. And, like I say, we'd adopt them. The entire staff would adopt them because one thing we wanted them to learn was the American culture, see what this country was about. And every one of them, I'm happy to say, left with a tremendous positive impression of the United States because I think the way we treated them and what we did for them. In fact, until this day we get Christmas cards from them and birthday cards, right, to this day. But the purpose was training and I'll be honest with you. I had a prejudice too that I wanted to see what was happening in those countries with this technology. Could we do in India with the eroded soils, screwed Phs, messed up water holding capacity, could we grow trees? I don't care what you grow them for, fuel wood, shelter belts,

erosion control, whatever, I don't care. Regardless of what the purposes are, first of all, the trees had to survive and grow, regardless of what you are going to do with the trees later on, and that was our mandate. We're going to get those suckers to survive and grow. And we did. And we learned so much about the biology of this technology from these studies in Morocco and Venezuela and Liberia. One thing I didn't mention about Liberia, it gets seven months of rain and five months of no rain. Well, everything is going to grow with eighty inches of rainfall seven months if they have mycorrhizae. So we put in a study, like I say, with Pinus Carribea, Caribbean pines and we had no non-mycorrhizal plants because that was nonsense. Why test that, you know. That's like say I'm going to have a child born but I'm going to deprive it of oxygen just to see what would happen. Well, hell, you know what's going to happen. So it's worthless to even look at something like that. So everything was inoculated. We're going to say there are certain fungi better than others. Well, I want to know when these trees are growing, so we ended up measuring them at the end of the rainy season and at the end of the dry season, and then we looked at the data almost as if there were two different growing seasons. It was and after three years eighty-five percent of the growth differences that we found due to Pisolithus was during the dry season. Everything grew like hell in the wet season and they shut down when the rain stopped. And Pisolithus has got this big giant vacuum cleaner and it was probing and finding moisture everywhere and these trees just continued to grow. We ended up with trees three times the size of other trees, unbelievable. And this is where Stan Krugman became a believer because he was on the editorial board of the journal. I forgot the journal's name. He was on the editorial board. He called me back he said I just got your manuscript to review. He said I'm not changing a word. It's going to be published exactly the way it is. Of course, keep in mind, it went through the station editor. Bob Biesterfelt is a fantastic editor. So by the time the journal got it, it was

already a polished document because it had been rewritten, you know, and everything else. And he became a believer. And that opened the door for other international agencies that were seeing those results. Can you do that in Ghana? Can you do that in the Congo? Can you do it in Venezuela, Brazil, Thailand, Sri Lanka, India? Yeah, I think. All I want to do is try. And we'd get the funding from OICD or USAID or wherever, sometimes the countries. The biggest problem was getting permission to accept a twelve hundred dollar round trip ticket from Sri Lanka to the Forest Service, so we worked out a deal. They would deposit the money in the Forest Service account in Asheville and I would draw up on that fund. There are ways of doing it if you really want to do it. And like I said, be creative. You guys are asking me to be a creative scientist. I'm looking for creative accounting. Is there a legal way that I don't go to jail where I can accept money from China, Taiwan, Indian, Pakistan, have that money deposited in my travel account under control by Asheville, and I draw upon that fund for my expenses on this trip. Did that for about twenty-five trips, no problem whatsoever. And to my knowledge I was the only scientist to ever use that procedure, and it's in the book. There are ways of doing it if you've just got someone willing to look in a book for you. This thing about well, I can't do that, I can't do this, can't do this, well, maybe you ought to look at it a little bit differently. Maybe there is a way of doing it.

When we first started we couldn't get soft funds in the Forest Service. I was on the faculty of University of Georgia. Get these mining companies to give this money to the University of Georgia Plant Pathology Department and then I would spend it from that because I was on the faculty and I could get reimbursed from the University of Georgia. And that's the way we did a lot of this until all of a sudden it was, I forget who it was said there's absolutely no reason why

you can't accept soft funds from other units, from other sources, as long as it's well defined, you have a cooperative agreement, and we have absolute proof that you're not putting the money in your pocket. And so we put together a bunch of straw man versions of cooperative agreements, ran them through legal beagles in Washington. Yes, this is no question. You can accept fifteen thousand dollars from the International Paper Company. And they're sitting there saying wait a minute now. All this research that Don is going to be doing the International Paper Company is going to be the first guys on the block to get it. That's right. You want to be first guy on the block, fund me. All of it is going to be published. It's not going to be proprietary. There's not going to any intellectual properties. It's all going to be published once it becomes scientifically evident that it requires publication. And just by chance it's funded by IP. We do the research in their nurseries and on their field sites. Weyerhaeuser is the same way. There's no prejudice whatsoever here. Everybody, and I freely talk about all the data. I don't care who it is. There was never any concern by IP like I paid for this; this is my data. Bull, they knew better, that we shared with the entire world. So there are ways of getting it done and we did it. And I will say this. Buckman was supportive of this. He gave me that twenty-five thousand dollars one time and he said that's a one time deal, Don. I said you sure you don't have a pocketful up there somewhere else. He said no, you've got your share, that's it. But he had discretionary funds that year, thank goodness, and he funded us to a point that we could rebuild that growth room and expand that growth room concept.

We also had others in Washington that, like I say, Keith Shea, Stan Krugman, and I'm sure there are others that I have forgotten that. Let's put it this way. We had very few jerks. We had very

few people that were not willing to listen to our proposals and ideas, very few of them. We had a few but very few, and I'm sure they had their reasons for not approving what we were proposing.

There were university people that we were involved with that we were able to get funding for that worked in collaboration with us. Oh boy, we've published with probably eight or ten different university professors on different aspects of this technology and we were, in several instances we were able to assist them in getting funding, because we just didn't have the time to do all the research ourselves. We were trying to get others encouraged to do it and at the same time train some students.

HKS: Is there maybe a budget level that the station director is authorized to approve and above that you have to go to the Washington office for approval? I mean is there some obvious hierarchy of decision making that the Washington office doesn't have to approve everything but they need to approve some things?

DM: No, Pete, I don't remember any of that. I don't recall once we had a system in place to accept the soft funds, I do not recall the station having any problem whatsoever with the amount of money we brought in. I will say this. I had station directors years later tell me that they did not give me all the money that was appropriated out of Washington because they knew I could go out and find soft money. A couple of station directors told me that after the fact that we knew that we got you mad enough or deprived you enough that you would go out and find the money. So we were able to take fifty thousand dollars away from your appropriated funds and give it to a project over here that's not capable of generating soft funds because of the nature of their work

and we knew that you'd go out and you'd find that fifty thousand dollars somewhere, which was fine, okay. We were able to do that. But see that's part of what I became weary at because I was spending more and more and more of my time generating money. When I retired from the Forest Service I had 1.3 million dollars coming in of soft money for my project, one and a quarter million dollars from three different sources. And every year these same sources would do it again because we were giving them their money's worth for the research that we were doing. And the research direction somewhat changed in the unit and that funding fell apart through basically no fault of anybody in the unit, just the simple fact that the objectives changed and that in large part was due to mandate from Washington, the ecological, ecosystem reports and this type of thing.

HKS: Was there ever much tension between, I'm not sure of the terminology that's used currently, applied research and basic research?

DM: Oh, yeah, yeah.

HKS: You had to have a certain percent as basic?

DM: No, I was, early on, now keep in mind I started out as a bench scientist. I was a pretty well trained plant pathologist, biochemist, mycologist. All I knew about the field was that I fished in lakes surrounded by woods, right? I was not a forester. Keep in mind that. I was actually trained probably more in agronomy than I was in forestry until all my work experience has been with trees and I have associated myself primarily with foresters during my Forest Service career, so I learned if nothing else by imbibing I guess from these fellow foresters that I

worked with to learn the forestry profession. But when I first decided to go to the field with the technology to look for a practical application I was strongly criticized, not so much by my supervisors, but by fellow scientists. This is not your job. That's the job of state and private. State and private is supposed to pick up what we do and then apply it if possible. I said well, okay, but the problem is that there's no one in sate and private that knows enough about the technology to be able to put it into practice. And that philosophy, and this went on for four or five years I guess, that had problems in some of the publications, this talk about the results of this study suggests that we may be able to manage species of mycorrhizal fungi to improve success of forest regeneration. They rip it out. Gee, why. Goddamn it, you know, this somebody else's job. Well, that happened. In fact, you can see in some of the earlier publications where none of that was ever mentioned until later on I finally was sticking it in there. But this was in large part why I got Ed Cordell involved, state and private, because he was the guy I was supposed to hand the ball off to. Now that's the way the policies are. The researchers do the research. State and private forestry do the application, and national forest receives the application, that and state and private.

Well, okay, but no, there's no question that we, most other projects in the Forest Service were doing basic research, which is great, fantastic. So was I until all of a sudden we made this technology discovery, whatever you want to call it, and the obvious application, all we have to do is try it and we did. We revamped everything for that but we still were doing basic research at the time. At least fifty percent of what we did was fundamental research and the other half was the answer to the question I used in my seminars. I teach a workshop here. You see all the students I've had up there. Next coming October will be our twenty-third workshop, anywhere

from twelve to twenty students here, all over. University professors come in. And what I do the first day I give them an introduction to how trees grow, photosynthesis, carbon allocation, marrow stems. It's amazing how people forgot how trees grow and plants. They compare how trees grow to grass. At the end of all this academic exercise, talking about mycorrhizal fungi, {**??? rhizo 357**} bacteria, nitrogen fixation, and all this biologically significant stuff, and at the end of the first day the last slide I show is a statement, so what. That comes home to me because for many, many years I would go to nursery conferences, pathology conferences and talk about all this basic work we had done with mycorrhizae, when we got through with the lab reports, lab exercises and the talk was over, I had a guy in the back stand up saying so what! What the hell can we do about it? And at that time, nothing, and that was part of what drove me to answer that question. Now with our company, of course, we are. But to be able to say you now the academics, you have some of the fundamentals, now we're going to wrap this up and show how it all can be applied, right? I just taught you how to make a clock. Now tomorrow we're going to talk about what's the significance of a clock. And it's fun. It's amazing. You can see light bulbs going off in people's heads, right? You challenge them. It's exciting. I love it.

HKS: It might have been when we were discussing the university professor scientist as opposed to the Forest Service scientist, years ago I interviewed Dave Smith, the distinguished professor of silviculture at Yale. I'm sure you've run across him. He's long retired.

DM: He's Gordon's protégé.

HKS: Pardon me.

DM: He's Gordon's protégé, right?

HKS: Probably. Anyway, Dave was saying that he's the last person that Yale will ever hire that has for the practice of in the title of what he studies, because he has a textbook, seventh edition, [**The Practice of Silviculture**]. He said it has to be theoretical. He said you mark my word. The new people they're bringing in are going to be chemists and physiologists. They won't really know what a tree looks like out in the field.

DM: That's absolutely true. You are absolutely correct. In fact, the problem is we're at the molecular level. In fact, I said so at one of the last conferences I went with, and I mean this was a dynamic, dynamic program that we're talking about. And talking about the DNA and the control on gene structure and stuff like this and it was basic fundamental science. I was one of the reviewers and they asked said Don, do you have any questions. I said does anyone know what a tree looks like, a whole tree. I said you've been looking at that piece and you've been looking at that piece and you've been looking at that piece and you've been looking at that piece. Somebody's got to put it all together. That's like going and putting your car in the shop. I've got a fender busted here, an axle busted here, a flat tire here, a radiator here, and you've got to send it to each specialist, but somebody along the line has got to look back and say hey, we put all the pieces back together. And the significance of that is. And we've gone to the molecular level, which is important. Don't get me wrong. We need to know that. In fact, we probably should have known that. It would have been good to have known that years ago but we didn't have the

technique. Good example of that is I do a lot of environmental work. Our reclamation company we do, Brownfield revegetation mining—

TAPE 6 SIDE A

HKS: Don Marx interview, June 21, 2005, Tape 6.

DM: All of a sudden they say, these people are saying, my gosh, all of these toxic elements that are present and all of this other stuff in these areas, you know. Well, the periodic chart I think we've got something like a hundred and twenty elements currently identified. Those elements naturally occur. Well, first thing, other than a few radio nuclear ties man has not created an element. Man did not create mercury, right? Did not contain this copper contaminant. These are naturally occurring elements in the environment. Here's the problem. When I was a graduate student at N.C. State when I took analytical chemistry it was rare indeed for us to have the instrumentation to be able to detect one part per million. That's the equivalent of one inch in thirty-two miles. We thought by God that's incredible, a part per million. Then about 1980 they improved upon the analytical equipment in such a way that they could detect one part per billion, that's three commas, today, a part per trillion. What you didn't see in the '60s because you did not have the detection equipment and that you now can see today by detecting a million times more doesn't mean that it only occurred today and didn't exist back then. Our problem is that we have forgotten that. Look at modern day contamination. It's always been there, you just haven't been able to detect it. We now know that plants accumulate nearly every element on the periodic table at one place or another or at one time or another and in frequently in concentrations that if

you ate like five tons of cabbage you could probably kill yourself. Well, first off, the cabbage by itself five tons would kill you. But seriously that we have such sensitive analytical tools today that we can find what are you looking for, and we can almost find it just about anywhere we look. We now have food crops, cabbage, broccoli, I have to get the list out, where we use to remove toxic levels of heavy metals from the soil. It's called fidal remediation. These food crops are accumulators of mercury, copper, zinc, all the bad guys, these plants accumulate them and they have been ever since we been eating them. But all of a sudden that cabbage contains a part per billion of mercury. Yep, and it always has. We can analyze you. Even though you have been the healthiest person in the world we can find almost all these heavy metals in your system.

What people forget, in fact, like I say, I make a point of these things in my lectures. Arsenic, the poison of kings and the kings of poison; Hypocrites used arsenic to treat ulcers. It was called the Fowler solution, used to treat everything from asthma to cancer for the last hundred and fifty years starting in 1786, first effective remedy for syphilis replaced by penicillin eventually. Used to treat African sleeping sickness, leukemia, still being used for that purpose today. Both a drug and a poison, it depends on a break. When I came back from Taiwan I picked up an internal nematode, parasitic nematode that was actually growing through my skin in little pustules. And I was noticing these pustules and I went to the lab one day and my nematologist, John {??? **Ruley**}, was there and I said give me a slide, we're going to cut some of this stuff out and look at it and here's this damn nematode. Ate through my arteries and veins and emerging through my skin. I don't like that, because I've picked up some weird things in some of my travels before. And by chance in the little town of Watkinsville there was a doctor who had treated Marines in Vietnam, a tropical specialist. I walked in to see George and I said, George, I've got these damn

nematodes. He said I know exactly what you got. No problem, we can fix that easy. He said how much you weigh. I said I don't know, two hundred and ten. He said no, I mean exactly how much do you weigh. I don't know. He said go take all your clothes off. He said weigh you. All right, you weigh two twelve. He said here, you have a lab, I want you to weigh out every day so many milligrams of this arsenic sulfate, so many milligrams for every hundred pounds of body weight, once a day and do it precisely, exactly, because too much will kill you and not enough won't get the nematode. Well, I did that for two weeks. Got rid of the nematode but I've never been so damn sick in my life with that damn arsenic, right at the level of almost killing you but yet it didn't, arsenic as a medicine. Now arsenic is one of our water pollutants detectable at one part per ten trillion. It's always been there and will forever be there because it's part of the mineral deposits of our soil. It's a naturally occurring mineral component of our soils. Why shouldn't it be there? And that's part of the reason why bottled water is so popular. I want you to click back eight years. Guy walks in got a bottle of water in his hand. I want you to invest in this company. And I'm going to have water sold in a bottle and it's going to be more expensive than gasoline. You would have laughed him out of the room. You know it's now a three and a half billion-dollar business, bottled water. It's all perception, isn't it?

HKS: It makes sense if you're in India to be drinking bottled water but.

DM: Yeah, okay, get off these. We're chasing wild rabbits now. Part of the university and the university experience I had not just as a graduate student but I was fortunate enough to be invited by university to be a visiting professor for a week, two weeks, this type of thing, to give seminars, interact with the graduate students. Without exception all of these visiting professor

offers you were offered money, what's the word I'm looking for? Well, usually five hundred dollars. You come, we'll pay all your expenses and we'll give you, I just had a mental block here, Pete, I'm sorry. Five hundred dollar, anyway, it will come to me. Well, I couldn't accept those. It was federal. So I always donated them to the graduate students' clubs and this type thing for them to have a beer-pizza party or whatever, you know, and that went over very well. But it was a very good experience. In fact, in many cases I was fortunate enough to encounter some pretty smart kids, young guys and girls, men, women, that later became scientists in either pathology or something and have developed associations ever since. But I was a visiting professor at Wisconsin, Minnesota, Nebraska, West Virginia, Virginia, of course, Georgia, Florida, Clemson, VPI, several, UCLA, various other places like this. It was an excellent opportunity first off not just to share with them some of the work that the Forest Service was doing because in most cases they were somewhat remote from that, but to interact with not only their research but also what their individual students were doing, which was an educational program for me also and I really enjoyed that. In fact, I still do that today. Honorarium, but today I can accept the honorarium. I don't accept it. I give it to the company.

HKS: We had a Weyerhaeuser vice president visit the office many years ago and he asked if there's an honorarium. I said no. He said well, it's okay, he said but the company has directed all of us to ask if you've got some money, we'll take the money. You buy our plane ticket and we'll take it. Otherwise, we'll come free but we always ask.

DM: Yeah, well, again part of this arrangement at university was that they could deposit money in my account in Asheville and I'd use that as travel expenses. Usually they'd pick up my motel

and lunches and meals because they're usually eating with you. So all I needed was reimbursement for a plane ticket and I just got it from that fund.

Okay, we're going back now again to NAPAP, the National Acidic Precipitation Program. I think we made enough probably comments about that. But there were several spin-offs of that program. One was called the National Vegetation Survey that was we had designed a program in that document where we had specific concentrations of ozone and acid rain that we were going to apply to tree seedlings and containers and this type of thing to find out basic fundamental physiology. But there was very little "forestry" observations involved other than the fact the original ones where we thought we had reported growth loss based on some of our forest inventory plots. So we put together this atlas like I told you yesterday, you know. We got all the data we could on weather and ozone and acid rain and soils and pests and fire and tree distribution, tree species distribution, and incorporated those into independent atlases and we had key scientists that headed up each of those. Here's a, that was published after I retired. But then we integrated all that. We were able to ground check. Like I said, this was an extensive, time consuming program. We got aerial photographs of all the major cities in the southern United States. We then photo interpreted those to determine the degree of woodiness, amount of woods in the area. And from that we could say all right, this degree of forested area, we could select or reject this as a forest type or not, because all of our ozone measurements came from cities. We later found out that these ozone detector systems were mobile and if they were out of compliance today they'd move that ozone around, that ozone monitor around to somewhere in the city where they were in compliance. It's all kinds of stuff going on. So question the reliability of a lot of that data but it was the only data we had. So we put together this atlas and we did a long check, like I

said, long story short, a lot of very smart scientists, no me, I had nothing to do with this. All I did was create the idea of the atlas and help put it together. But we got a great deal of functional information out of it. We got the first report of the good distribution of fusion form rust and other diseases and type of thing. But the big thing was we were able to basically come to the consensus, the scientific consensus, that eighty-five percent of this apparent growth loss that we were seeing in our commercial forests in the South, is due to erratic rainfall patterns and not air pollution. I'm not saying that air pollution is not involved but the major problem is that we're just not getting enough rain at the right time, which has always been the case.

And then about the same time we realized early on that we simply did not have the research facilities to do pollution research. Other than the Acid Rain Foundation that came from N.C. State that was a funding source for people, there was "nobody" in the southern area in any school, any department, that had facilities to do ozone, sulfur dioxide, nitrogen oxide, acid rain, carbon dioxide research. So we discussed this at one of our annual meetings and I went home and contacted a colleague of mine, Dr. Dan Brown, who was with forest pest management in Atlanta, Region 8, and he and I had talked about general issues like this before so we said what we need to do is to create a center of excellence for the Forest Service, where we will design and have constructed state of excellence, state of the art research facility to study acid rain, sulfur dioxide, nitrogen oxide, carbon dioxide, and all these issues that are becoming apparent. So we drove down to Macon where the headquarters of the Georgia Forestry Commission is and we met with the state forester and I have to apologize, I forget his name. Very receptive man and I said this is what we want to do. We don't own land. Of course, we had the Forest Service fire lab there, Macon fire lab and the meteorological board dealing with smoke and fire. Right next door

is the Georgia Forestry Commission headquarters. What we would like to get is a couple of acres of land from you, like right out there, and a co-opt agreement with you guys, you donate us the land and supply the plumbing and sewer and the electrical work and you got the prisoners doing all the landscape work in a co-opt. He says that sounds like a plan. That's the Georgia Forestry Commission, be the only place like it in the world. Long story short, within eighteen months we had it under construction, two million bucks. And to my knowledge, to this day, oh, by the way, also we had the Forest Service seed lab in Macon, which is right next door, where all the seed collected. So it was multiple reasons why we selected Macon. Also, it's what I call the belly button of the South as far as commercial forests are concerned. You could not find a better place for dead center for meteorological, everything else. Easy to get to out of Atlanta, you know, it's a perfect location. Well, we got approval, no problem. Hey, that sounds like a good idea. Charlie Philpot was involved. Lamar Beasly maybe, I don't recall. But we brought in some experts from all over the world to help design it, the schematics and what we needed, individual chambers and stuff like that. Well, it ended up being a massive greenhouse. Now Macon, Georgia gets pretty doggone hot in the summer. We had air conditioning you could freeze water just about in the greenhouse mid summer, had that capacity. We designed it because we needed maximum control. Many, many successful studies were done in there. The thing about it is what we did the policy was we are going to make this facility available to anyone who wants to do quality research on air pollution, air quality, this type of thing. And we had a research board that would approve the applications from Yale, wherever they were coming from, that yeah, all right, this study is good enough that we will allow you to use this facility at X number of dollars a month and it was full. I mean we had people standing in line because it was a unique facility. Some very good research was done out of that thing and we had some people in charge and again I

apologize, I don't remember their names, some young people we had in charge. There was one young lady named Ann Lawton I think. She got her master's degree in Florida on mycorrhizae and I was on her graduate committee and we got her positioned at that facility to be one of the technicians and to manage the mycorrhizal complexes and these things and as far as I know she did a good job. But again, that was a spin off of the NAPAP program. To be honest with you, I'm not too sure where all of the funding came from. I didn't ask. All I know is, wait a minute. Sesco was station director. That's right because he came down for the dedication. And I'm trying to remember who else came with him. Did Eldon come down to that, Selina, that dedication, the Macon lab?

SM: I believe he did.

DM: It was Jerry Sesco. It may have been Eldon Ross also. I forget. But it was a lot of publicity. Like I said, if I were to start over again I would have loved to have that facility to work with. It was that state of the art, because they had at that time all the electronic monitoring devices for all of these air pollutants. It was quite good, quite an effective organization facility. And to my knowledge what we tried to do, which is somewhat different in the Forest Service, is that we charged them money to use it. What would it be, like renting it, you know, say okay, we'll give you this greenhouse bay where you can have a bench this big and all this other stuff to do this, this, and this and the guy next door is going to be so-and-so and so-and-so. So you do your job, they do their job. We're going to charge you five hundred dollars a month, whatever it may be. I had nothing to do with that. That was part of the arrangement though. But again that was a spin

off of some of these programs that were not necessarily scientifically driven but probably more politically driven that ended up doing some pretty doggone good scientific research.

HKS: Duke had what they called a growth chamber, which was a greenhouse, with ways to heat it and cool it and all that.

DM: Oh, yeah.

HKS: And it was busy all the time and co-opt work, and would hire it for a growing season or whatever it was.

DM: Exactly, sure.

HKS: I don't know how sophisticated it was compared to what you're talking about but.

DM: Well, at the time it was the envy of everybody. It was the most modern facility anywhere in the country to do this type of research. I'm sure today there are others but you have to keep in mind this was eighteen years ago. It's been that long. It's unbelievable.

All right, then along comes 1991, China. I was approached by a group of American Chinese in San Francisco that had learned of some of the work that we had done with mycorrhizal fungi in Athens and we had also had some Chinese scientists visit us and spend some time with us. And this, the name of the organization, Selina, help me, American Chinese for Chinese Advancement

or something like this. It was a non-profit organization and they said would you go to China and educate them and see what's going on because at the time you have to realize we were getting reports that China had the world's most successful artificial reforestation program of anywhere in the world, that they're planting billions of tree seedlings a year successfully. Well, let's put things in perspective here. United States produces nationwide about 1.8 billion tree seedlings a year for reforestation. Two thirds of those are produced from the South. Total number of plantations we have in the South is about twenty-five million acres, and they've got a program ten times bigger? Where in the hell are the nurseries? We've got a nursery, Weyerhaeuser nursery outside of Augusta that produces one hundred million seedlings a year, one hundred million a year. In Sweden, Stora has got a container nursery operation that produces twenty-five million seedlings a year, which is the largest I ever heard of and all of a sudden we're getting these reports. I said yeah, I'd like to see that. What we want to do is look at some nurseries and look at some reforestation sites that were established from nursery seedlings. These nursery seedlings here were out planted. So we arranged all that. They helped us interact and everything else, got permission from the Forest Service. Ed Cordell and I went. We brought our wives. Again, Selina went along as a volunteer. She paid for her own way and everything but she was our technician. We took off and we had already been to India a couple of times and Venezuela and Brazil and had experienced some maniac drivers, you know, in these places. Well, about two weeks before we got to China they had major flooding, washed out most of the major roads, and had a cholera epidemic. So we beefed up on gamma globulin. We pumped gamma globulin just like it was Karo syrup, you know. Went anyway. Well, the roads were in horrible shape, bridges washed out, and we were driven by a bunch of maniacs that they don't use headlights at night. They only use headlights when they think there's another car coming. Of course, no one's got

their headlights on so you don't know. They blink their lights. I don't know why, a problem of wearing them out or what. But we had a disaster. We drove in a ditch and our interpreter in the back hit her head on the doggone roof of this VW bus and was knocked unconscious. The interpreters I'm sure were intelligence officers. We were not permitted to go certain places and it was always the excuse of well, all those roads were out, you know, but you could see traffic coming that way. I will say this. Regardless of where we went, and we were in the boondocks, this was in the remote areas of **{??? Fubay 336}** Province up there in Outer Mongolia, places like that, that wherever we went we were the honored guests. We would go into a small village and the mayor and all the officials would be at the dinner table. And I am convinced, Selina and I are convinced that they gave us the best food they had and probably went hungry themselves.

We went into this one logging area that's a forestry camp. All the forest workers worked there. There was a great big sign when we drove up, welcome Americans. Of course, half misspelled words and stuff like this. And we were like we were welcoming returning heroes. I mean everywhere we went it was incredible. We had tremendous interaction with these people. The biggest problem was language. But Ed Cordell and I, we went prepared and we gave an average of four hours of lectures a day. And in some places drawing pictures on chalkboards, you know. Power outage was very common. Projectors didn't work because of no electricity. It's called improvise, you know. Make do with what you got. But we examined several nurseries. Biggest nursery we saw produced about a half million seedlings a year, about half an acre. Had fifteen, twenty people working on it. All the seedlings were hand watered. And I keep asking where are the hundreds of millions of seedling nurseries. Well, it turns out most of the reforestation is by direct seeding where you have seed collecting areas because you're talking about millions of

pounds of seed. So we examined some of these areas and I hate to be this blunt but we did not see a lot of success. The only success we saw was loblolly pine, was southern loblolly pine where they had brought in seed using our nursery technology containers and planted some trees twenty-five acre plantation, whatever. By the way, we found PT there, Pisolithus tinctorius there.

Three years before our visit we had a Chinese student, Ed Cordell and I had a Chinese Ph.D. that we trained in our technology went back to University of Beijing and duplicated our procedures and mass produced Pisolithus inoculum and inoculated a whole bunch of trees with great success. There's a book up here on it. It's on Pisolithus. It would take me a while to find it but basically it's all Chinese except for the summaries that are in English. Remember what we did with that book, **{??? Chao Mae 393}**? Anyway, they duplicated everything we did and they had similar success to what we had. They also found that our strain of Pisolithus that we had been working with was superior to the native strains of Pisolithus in China. So we gave them our strain to work with. He doesn't need to see that, Sugar.

SM: Okay.

DM: We put together a reforestation program for them. They had made a power dam, hydroelectric dam. The dam was about two hundred and fifty feet tall, earthen dam, backed up and created what was supposedly about a four hundred or five hundred acre lake by hydroelectric. Well, as soon as you make flat water all the natives come. They build homes on a hillside, cut all the trees down. They build their homes, make fuel wood and erosion. Within six years that entire lake was completely silted in and when we saw it six years after it was originally

flooded, it was now growing sugarcane. Had a creek in the middle. No reforestation, no managed watershed, horrible.

HKS: A guy named Walter Lowdermilk, Soil Conservation Service guy in the '30s went to China. He also went to Israel, a lot of places after the war. And he's most famous, he came out of Berkeley, on reforestation to protect water—

Tape 6, Side B

HKS: Okay, the problem is?

DM: Population pressure. I mean every square inch that we saw, we're talking about some rugged three one slope mountain sides, where some Chinese family is living there, you know, hanging on to the slopes of the mountain, and every square inch around the rocks they'd have cucumber plant or squash plant or some food crop growing in that area of soil the size of a coffee cup. The flat areas, the low land areas, they had rice. Every square inch is in rice production because that's their staple, of course. So all of a sudden now you go up there you dam up this river, this creek, and you now have flat water, no more running five miles an hour. You got it flat. They catch fish. They can use that water for irrigation. And they cut the trees. Now this new dam they're building now, this multi million dollar dam, I hope somebody has got the foresight to do something about watershed management or it's going to be another disaster just like this one, but anyway.

HKS: You must get the same stuff in the mail I do. Go to China before the dam is finished and the reservoir changes it's canyon. You take boat rides through this area now. In another two years I guess—

DM: You're absolutely right. We spent a night on the banks of the river, the big river, and it was running flood level, all kinds of debris floating down the river, and there was nothing but solid mud from erosion, and this was 1991. Anyway, they wanted us to work with them on producing custom made seedlings for their adverse sites, which was just about everywhere. They had their Mongolian, this was the U.S. China Foundation for International Exchange. That's who the group was that funded us. Let me look for this. There were several of their native pines they were interested in but there was one major, it was popular. I want to get the correct name here. Mongolian scotch pine and also, boy, it's a helluva note when your mind goes, you know.

HKS: I saw slides by an inner Mongolian forestry professor on reforestation somewhere near where he lived and they were going out in the day watering the plantation by hand.

DM: Yeah.

HKS: And once they got established they could survive but.

DM: Well, in the nursery, the biggest nursery we saw was about two or three acres and they had this water wagon and they could man handle about a fifty-five gallon vial of water and they had these little sprinklers on it, ran out gravity flow and they'd pull a plug and they got to push like

hell until they ran out of fifty-five gallons of water and plug it back up and go get another fifty-five gallons of water. That one guy it must take three days to water the nursery, this guy, but they got plenty of labor. That's not a problem. There's plenty of labor. Anyway, we put together the last couple or three days we were there we put together a reforestation program based on direct seeding. We found some interesting things. It's all in this report. The Mao said that you will each province, this one province we were in, for example, {**??? Hubay 048**} Province, they are by mandate from Mao that they would reforest seven thousand acres a year. I mean they had a backlog of hundreds of thousands. And direct seeding was the most effective way of satisfying that seven thousand acre requirement. So the first question you ask is okay, what seed, where are you getting your seed? Well, we have seed collecting areas. How many seed per acre do you apply, and they give me a number and look at that. And we looked at some of these areas that had been direct seeded and there were about fifteen trees per acres. Seed use efficiency meaning how many trees came from so many seed, it took seventeen hundred seed to net one seedling. Of course, we don't know what the seed quality was. Not only that, there wasn't always a species that they said it was. Whatever seed they had they flew it out of the airplane to satisfy that quota.

So we put together a proposal with them that we would use PT spore encapsulated seed. We developed that with the Swedes, {**??? Hillishot 062**} Seed Company, that's in there, where we could with a special mastic stick Pisolithus spores on the outside of pine seed, and the seed was viable and it carried with it it's own mycorrhizal inoculum and was very, very successful. We used it in tree nurseries here in the South for years. And we said all right, this is what we will propose for China. You send us or we will find a way of encapsulating your Mongolian scotch pine, whatever other species of pine you have, we can stick the spores of PT on it. We will also

come in. Their nurseries were truly organic. Ed Cordell and I were out there digging roots up in these nurseries and we were seeing the roots just black, just burnt. And we kept asking how are you fertilizing these. Well, we never got a satisfactory answer until one day we saw two people, two men, shoveling out the remnants in the open pit toilet that we had to share with everybody. Put your feet in the marks and squat over this hole. Well, that generated some very comical times, some very funny things, but anyway.

HKS: Called night soil I think.

DM: Night soil and they would get this fresh material and they compost it right there at the nursery for about five or six days and they use that as fertilizer. Well, needless to say, we didn't bite our fingernails for quite some time after that. But what happened was we eventually brought back to the states some soil samples that we had permission from quarantine to do, because I had a lab. I had designed my lab with a, we could bring foreign soil in and the water was filtered microscopically to remove all pathogens and then we autoclaved the remnant liquid. So we had international soil processing. We were not going to introduce foreign pathogens in the United States with our facility. We had a way of cleaning it up. In fact, it became a standard at almost all soils labs to use our technique. It was a series of filters down to two microns in size and then we **{??? audit 094}** them. Anyway, we analyzed this soil Ph of about seven five. Well, conifer is like five, and what we had was an ammonium generator. That organic nitrogen was being converted to ammonium and that ammonium would burn the devil out of the root system of the trees. No mycorrhizal development on them more or less because the roots were dying. I mean you've got to have a living root before you can put mycorrhizae on it. So we put together a

program for them that they could process the night soil somewhat differently to bring in other organic material to create a less alkaline compost, and we know how to do that. I mean that's standard procedure and we put together that plan for them. We put together a direct seeding plan for them and a way of detecting success or failure. We'd go out there with plots that we could put on the hillsides with color-coded toothpicks, you know, by the seed. We had everything worked down pretty good. Cordell and I were prepared to come back to China and implement these programs together with them and this U.S. China Foundation for International Exchange was willing to work with us on getting it funded. They had influence they thought. We were excited about it, thought we could really do some good. Unfortunately the politics got in the way and it was not even, would not even be seriously considered at that time at Washington. So, like I say, by the time we put all this together it was August 1991 we put this report and thought we would get things going by 1992 and it just wasn't going to happen. We were able to find some slice and loblolly pine seed for China that was in stockpile in Florida and Forestry Commission in Macon, Georgia Forestry Commission where they had stockpiles of pine seeds that they hadn't been able to move and China bought them all. So Georgia got some money back and Florida got some money back. We exchange of scientists after that from China that came to the states that worked with us in nursery production. The thing about it is it's like comparing a Cadillac to a horse drawn buggy. When they come from China based on their level of technology and their nurseries, which are labor intensive, hands on intensive technology if you will, to the United States to even an average type of tree nursery in the southern United States producing twenty-five million pine seedlings a year, mechanized. I mean the entire nursery operation with twenty-five million trees has six employees, right? In China you've got a two-acre nursery with forty employees. And they just couldn't comprehend this, you know, that precision soil,

fumigated soil, perfect soil management for fertility in organic matter, have a machine that precisely placed a pine seed on two and a half inch centers on eight rows and it's a four foot wide bed, precision sewing. We had seed that were ninety-eight percent viable. They had no idea what the viability of their seed was. They just go out and broadcast it and they get a bed of seedlings up. Then they go out and lift these seedlings up and then go and prick them in the ground individually in the row, labor intensive. They ended up getting to where they wanted to get. But they didn't understand the basic biology. So much of what they were doing then was a dictate from Mao. You will use naturally occurring minerals in your vicinity for your fertilizer. If you wanted potassium or calcium or magnesium or phosphorus for your nursery, the nitrogen came from night soil, that you would find a mineral deposit in your vicinity and you would come back and make use of that mineral deposit. We went into nurseries that had these barrels lined up along side of the road full of water and different rocks that every now and then a couple guys' job was to come along with a great big iron bar and beat the devil out of these rocks to put into solution the potassium that was there and then they would ladle out the liquid. Had no idea what concentration of potassium, whatever the element was, but they knew they could do it this way and put this much on per five linear feet of nursery bed and the plants grow. And that was their technology and it apparently worked for them. The biggest problem they had was the nitrification problem, the ammonification of the soil and burning the roots off. They did not comprehend what that was, because you could smell the ammonia. I mean it would almost make your eyes water and it was damaging the root system of the plants.

Anyway, we put together this program, designed some nurseries for them, and it all, excuse the expression, went to hell in a hand basket. They were willing. We were willing. Like I said,

because it was politically not correct at that time, we were able to get some scientists from China to work with us at our facility to pick up the best they could on what we were doing and how we were doing it and stuff like that. And we just freely gave away whatever they, whatever we had. Keep in mind it was all published information, in the public domain anyway, and all they had to do was go to the publication and get the same information but they came over in person and we gave it to them personally. And we gave them a stack of publications to take home. That was somewhat of a disappointment. We have been contacted, our company has been contacted by China to follow up. A year after my retirement three of the forestry ministers from China came here, sat right there, and wanted us to build a facility in China to mass produce Pisolithus inoculum in China. And we sat there, we negotiated, yeah, and they expected us to give it to them. They had no idea of a capitalistic system. This was what, Selina, in 1995?

SM: Uh-huh.

DM: Four of us at it. One of them was the equivalent of the chief of the Forest Service in China. Another one was in charge in forest management or something at least. Said yeah, we can put together a facility that will mass produce hundreds and hundreds and hundreds of pounds of Pisolithus and our best estimate it's going to cost you a million dollars. Well, they were horrified that we in the rich country of the United States of America would actually charge them to produce this inoculum. Well, needless to say, they left here very unhappy campers. See the Forest Service, we offered to do it for them when I was with the Forest Service for nothing, to show them how to do it for nothing. But it's no longer Forest Service. This is now a company. And they were asking me the same questions. We were prepared to give them free information

and everything else on how to go about doing it, train their people, and then in three short years the whole thing changed. So they left without the technology. I said we'll sell it to you.

HKS: My few experiences with people from, I'll just call the Communist block, has very great difficulty understanding our idea of competitive work.

DM: Not only that, their logic is so far away from ours. We were approached by the Eastern Europe, Eastern German government. This was after the wall went down in, we were invited in 1995, this company. We actually were not even a significant company. We were just putting it together. Would you come over and look at our coal mining rehabilitation program in Poland, Czechoslovakia, former Eastern Germany, come over and take a look at it and see if there's any kind of a way you could work with us to improve upon what we are doing. So Selina and I took off with a couple of other people, our people, and went into former eastern Germany, Poland, Czechoslovakia and looked at what they are doing. It was a disaster. And the European community had been funding the rehabilitation of former eastern block at millions and millions. In fact, the factories that we saw were the most modern in all of Europe because they were the most recently built, with money from the other guys, the taxpayers, right? They were very, very aware of the problems they had with reclamation. Our problem was that we could not be assured that if we came in that we would have funding available in a year to pay for us. They still didn't comprehend that. Sure, we could come in and do all these case studies and demonstrations you want and everything else, but once we prove to you that this technology is valid, we want the assurance of a program. Our shareholders demand it and couldn't do it. So needless to say, we did not seriously address it. We did work with some people for them locally to do some things

but that's about all we could do. But it was amazing. We met some very interesting situations over there. One big guy came up to me through a translator he said why the hell did you Americans divide Berlin up. Dammit I'd be speaking American now instead of Russian. It's unbelievable. They've still got problems.

But we were in Poland two years ago. Many, many years ago we had a scientific exchange program with the eastern block. We had scientists at our institute from Russia, Poland, and one of the young Polish scientists came in with their interpreter, spent a week with us, very smart guy, sucking up everything like a sponge. One of the few guys I allowed to have a tape recorder. Well, some thirty years later, I guess at least thirty years later, I get a letter from this guy. He said we're now free. Please come back to Poland and let me set up a big symposium and this type of thing. So we flew over to Poland and met with him. He became a distributor of our products there. He had to first get the product registered. We had to put in two-year field study to show that the products worked and they worked and they got permission to start applying the technology into the Polish reforestation program and reclamation program. But it's amazing. It's a small world. I mean here thirty years afterwards, well, let's put it this way. The guy changed physically quite a bit too. I mean when I saw him he was about 5' 8" about a hundred and forty pounds. He's still 5' 8" and he's about three hundred and forty pounds now, nice guy. He was the equivalent of the chief of the Polish Forest Service last five years. We were there, turned out we were there in celebration of his retirement. They had put together this symposium in honor of his retirement and I was keynote speaker. It was quite an exciting period, very interesting. But all these things come back. Thank God not everything comes back to haunt you. I mean sometimes what comes back to you is good stuff.

Like I said, China, it took us two years to resolve that, trying to make it work out and it never did work out. Well, then one evening in October or November of 1990, this is before the Chinese trip, I was working at the Savannah River plant. Came home Friday night very late about eight o'clock at night, hot, working hard in the field, and walked in the house and Selina said you got a call from Sweden. Who, because I had four or five colleagues in Sweden that I had been working with for years and gave a Swedish name and she said it sounded something like so-and-so. I said well, it sounds like one of these guys I'm working with. She said well, regardless, he wants you to call him immediately. I said hell, it's one o'clock I the morning in Sweden. She said he wants you to call him. Well, I thought there was a personal disaster with this guy or something because, pardon my expression, but all these Swedish names sound the same to me. [Imitates a mock-Swedish name.].So I got on the phone and called the guy and it was the president of the Wallenberg committee and he said you won the Wallenberg prize. I said this isn't a joke is it, what is this, because I didn't know I was nominated for it or any damn thing. He said congratulations. You are the 1991 recipient of the Marcus Wallenberg prize. Well, it was the biggest shock of my life. I mean I couldn't talk. I couldn't do anything and Selina looked at me she said you got pale, you know what's the matter. And talked for about thirty minutes and I says, he had a sense of humor too, very nice guy. I said is there anything I can do to screw this up between now and when I get the prize and he said no, no. [Laughter] I said thank God, you know, because if I've got to wear shiny shoes and a suit everyday between now and then it's not going to happen. But anyway, they had set up a protocol, you know, to release it to the public and all this other stuff. Had to fly out of New York to meet with the people there at the Swedish embassy and go through all the protocols and find out how we were going to do it and everything

else. And he said all right, we'll need a list of people you're going to bring. Well, Selina and I sat down and there was some significant money associated with it and it's pay back time. So in addition to the entire family, all my kids and their kids, their husbands and wives, I invited my entire staff, secretaries, technicians, Ed Cordell and his wife, Art Kellum, old major professor. You guys are going to be there as my guests. It's time to say thank you. Well, we sat all this up. It took a bit to do it. Of course, not everyone could go because of conflicts in schedules and that. But we went over there and we had arranged, one of my daughters had arranged for local housing for the people I was inviting. I mean the Wallenberg committee set us up, the family, the immediate family, at the Palace Hotel, which by today's standards is about a thousand bucks a day. I mean these people know how to throw a party. Well, we had arranged for the people we had invited over to stay at four-star hotels and we were going to pick up all of the expenses. Well, somebody on the Wallenberg committee overheard one of my technicians comment was that boy, this is the dirtiest rooms he's ever seen in a hotel. Immediately the Wallenberg committee moved all these people out of that hotel and put it in a five-star at their expense, Wallenberg's expense. We're talking about twenty people, Selina? Twelve, fourteen, sixteen people, they picked up every cent of the expenses. Limousine transportation, picked them up at the hotel, transport them to the activities that were taking place so they could participate in them.

HKS: Is this a forestry award or a science award?

DM: Forest science.

HKS: Who is Wallenberg?

DM: Marcus Wallenberg was the Swede who got all of the Jews out of Europe and after the war he disappeared. Turns out that the Russians had killed him within twenty-four hours after his capture, that he is probably personally responsible for thousands and thousands of escapees from the Communist system. And he was eventually killed by the Russians. In fact, it wasn't until, what, four years ago, Selina?

SM: Yeah.

DM: That the Russians finally admitted that yeah, we took that sucker out twenty-four hours after we captured him.

HKS: Where did he get his money? What did he do?

DM: Mining, copper mining. Wallenberg family and the association, the copper industry in Sweden brought in ninety percent of the total revenue for the entire government dating back to like 1100. We went into a mine, a copper mine. After the ceremony they flew us to—

SM: Falum.

DM: Huh?

SM: Falum.

DM: Falum, the headquarters for this copper mine, and went down this copper mine that had been in continuous operation, don't quote the number, it's like impossible, since 1200, right? And has been the primary source of income for the entire Swedish government for their taxes and everything else and to this day a significant part. Now these are all deep shafts. We went down probably three quarters of a mile down into these, old wooden ladders and all this other stuff, you know. It's still kind of primitive. Be a sign here like this wall caved in here and there's four miners buried, you know, this type of thing, pretty rough way of earning a living. The Stora is the sponsoring agency of the Wallenberg Foundation, Marcus Wallenberg Foundation. And Stora by chance, coincidence, was the supporting company when I was working in Liberia working with the Liberian Forest Cooperation. The Swedish government through Stora was interested in the production of long fiber tree species, pine. That's what got us involved in the Liberian program. But I didn't know Stora then. I mean it wasn't until later that I found out about Stora when the Wallenberg. But the Wallenberg award was, it's an understatement to say it was significant. I found out that I did not want to be the center of attention for three days. We changed clothes three times a day from tuxedos to what were the terms they used? With a black suit and tie, whatever they call that over there.

SM: Black tie.

DM: Yeah. Giving two and three presentations a day. University of Uppsala, got picked up by a stretch limo, took off to University of Uppsala and gave seminars there.

SM: You didn't mention the Forest Service people who came.

DM: I haven't gotten to that point yet.

HKS: Don Marx interview, June 21, 05, Tape 7

DM: Whatever success I had it was due to all these people. I mean there's no way anything could be done alone. I mean all the awards that I ever received they should have had twenty-five people's names on those plaques as well as mine, and I made sure they always realized that because you can't do this work alone. But there's a time to say thank you and everything else and we had a blast. It was a wonderful period of time. But we had open invitations because everything was by invitation. Wallenberg committee invites you. You receive an official invitation. Whoever we put on the list they would receive I mean official invitation to the Wallenberg to meet the king and queen, you know, and all this highfalutin stuff. Well, Jerry Sesco and Eldon Ross wanted to go because they were part of what we were doing. I mean they are the ones that signed off on all the stuff that I was requesting. Buckman was invited but he wasn't available. Jim Trappe was there because he was in Scotland and we brought him over to the meeting. Another reason why I invited all these people I wanted somebody in the audience to applaud, you know, because you can be looking at a sea of strange faces. We had dinner one night. One night we had dinner with the American ambassador and his family, wonderful people. And the next day we had dinner with their equivalent to the chief of staff. And another day we had dinner with the guy that was the commander general of all the military. I mean this was high muckety muck. I mean sitting there with a damn general, you know. He said I understand you

were in American Marines. I said yeah, but I was a damn bunk sergeant. [Laughter] All I did was walk through mud and sleep in holes. Oh, we had great respect for American Marines, you know. Glad to hear that. Of course, I wasn't going to tell him that he hadn't fought a war in what a hundred and eighty-five years in Sweden. Anyway, incredible experience, wonderful recognition, and on the way home people were hearing about what was going on and got invitations to speak in Spain, London, Germany, where else, Selina?

SM: On the way home that was all.

DM: Yeah, stop off here for a day give a couple of hour seminar and fly this place on the way home and then, of course, when we got home it was red carpet. The Forest Service treated us very well. There were things that we could do now that we weren't able to do before because of the Wallenberg. And you know as they say, if you've got it, flaunt it. Well, we were trying our best to make use, the Forest Service, not only me project wise, but the Forest Service to make mileage out of this. Is there any way that we can use it as the next step to progress in research? It was very effective at the Savannah River site and DOE. The DOE director was an ex submarine driver, Navy guy, and first meeting I got in with him, you know, and he says well, damn Marines, you know, we always have problems with Marines. And I said well, that's why we kept you guys under water. We had a good camaraderie with him and then the next thing I know I got a call from him, he said come on, you've got to come over and bring your wife next week for a luncheon. He wouldn't tell us what it was. It was to accept an outstanding scientist award from DOE. It was the Wallenberg, but it was recognition for all the work we did at Savannah River site. We had by that time fifteen years of experience with research at Savannah River site and

some fifty, sixty scientific publications in refereed journals that me or some of my scientists did that all gave credit to this money, this research was done by money donated by DOE, cooperative agreement number so and so and so and so. So they got their mileage out of it too.

Like I said, we made use of that and then the next thing I know I think it was 1996 that Gene, oh, my Lord, I just forgot his name, Namkoong, the station geneticist received the Wallenberg. **[Proofreader's Note: In checking the spelling at mwp.org, I discovered the year was 1994.]** So it was really a coincidence here Kent Kirk, me, and Gene Namkoong all studied in North Carolina at N.C. State, and I don't think that's a coincidence. But the research we did, keep in mind you're given the award because someone nominated you. To this day I have no idea who nominated me. I tried because I want to thank them, you know. I'm sure Buckman had his hand in it and I'm sure that somewhere Jerry Sesco and Eldon Ross had their hands in it, but they would never admit to it. Wallenberg committee would not discuss it at all. No, that's confidential information. You can't get it.

HKS: Wayne Swank was nominated.

DM: Yes.

HKS: And he sent me his ten-page nomination package I'll call it, written by I don't know who of why he. Well, he broke his work into six areas and so on and so forth. So that's why I asked.

DM: No, he got it because he was not given the award.

HKS: So he saw it after because he wasn't?

DM: Yeah, and I was involved in his nomination.

HKS: When I talked to Buckman about you and what I should ask and all that, I'm not sure he was more impressed by you got the award or you brought all those people there, used your award money to bring family and friends and technicians and all the rest.

DM: Pete, there's a time you say thank you, you know. This was just an opportunity to. I have a recording of my acceptance speech that is very emotional. I couldn't do it again today. But if you look back and I search my soul to honestly go back and look, there were so many people that were so critically important in the decision making and guidance and mentorships and all this other stuff, you know, it's just like anything else there's nobody alone. You never sail alone, right? There's always hundreds of other people that impacted you positively or negatively. They helped shape you whatever you were. And Selina and I made the decision said that I mean this is significant money and it's unimportant. I mean we never not have a roof over our head. We never not have a meal, food to eat. Great kids, it's time to have a party. And I will say this. It was very personally gratifying to me to have these people sitting in the audience and get as emotional as I did, great. I get emotional now.

HKS: I don't know if you know Jeff Burley.

DM: Sure, yeah, hell.

HKS: I knew him when he was president of IURFO and he brought me to Oxford to work with him on a project that never got off the ground, an encyclopedia project where I do the history part, and anyway, that's why I was there so I got to know him pretty well, guest in his home and all that. He's one of the world's nicest people.

DM: Oh, Lord, Jeff is one of the, he's one of the best.

HKS: But I haven't been in touch with him for three or four years and he updated his email list to everyone who he ever emailed with so I updated my new address and I put a note on it, you know, what's going on. I told him what I've been doing for the past few years. He said he's given up all the things he's done. He's sixty-nine. I'm seventy. I was there on my sixty-first birthday and his sixtieth was just, so I know how old he is. We're right together. And he said the only thing I'm maintained is I've taken another term as chairman of the Wallenberg committee.

DM: That's right.

HKS: So I said this is coincidental. I'm going to talk to one of your guys. I'm not sure if he was involved in the awards when you got it.

DM: Yes, he was.

HKS: He was, okay. So I asked him two things; is it true that American forest science is not highly regarded because it is part of agricultural research and that the true scientists, the physicists and the chemists and so forth, just don't see agricultural research as scientific. It's important but it's pedestrian, it's applied, it's all these things. And he said yeah, it's true world wide, that forest scientists have a tough time making it with so-called the real scientists. But he said what they're looking for now and maybe it's always been that way is not someone who's had a long and distinguished career. He said there are a lot of people like that. We're looking for the breakthrough. And when you were talking earlier about how you did all your stuff, I could see the word breakthrough keep popping up.

DM: Yeah, that's it.

HKS: The breakthrough, and that might distinguish you from say Wayne Swank and others who were distinguished scientists in every way, who got cash awards every year for exceeding their job description or whatever it is and yet there was no breakthrough.

DM: There's no question, absolutely. Here's the thing, we talked about it yesterday briefly. There are scientists who have chosen the profession that they're not going to make earth shaking results because they're going to be doing nothing but trying to observe and monitor a massive system that may take thirty years. It may take their entire career like Wayne Swank chose with is hydrology work. Whereas, in my case, the longest experiment I ran was nine years. Most of them were two or three years, so turn around time. So I receive the benefits of having chosen an area of research that I could crank out publications, over two hundred and fifty of them, well, two

hundred in the Forest Service, and get results very quickly. Whereas, guys like Wayne Swank and that with the weirs and everything else, unless there's a natural flood coming through, there's very little unusual new information. It was a constant monitoring program. It was just like, let's put it on comparison like this here. The doctor who gets the attention is the one who treats the sick. Rarely does the doctor get the attention if he does nothing but treat well people. I mean Wayne was monitoring a health ecosystem, just monitoring just how these systems work, the carnivores versus the hardwoods and this type of thing, the watersheds, measuring this, this, this, and this. And basically you're doing almost the same work every year, and what you do you make reports. And it's like I say, he did outstanding research, he and his team. Like I said, he got the cash awards, the outstanding achievements and all this other stuff, but it's different from those of us who were doing research with having more immediate results that we could measure, physical results, much more physical results when you measure this tree is bigger than this tree. So I had the advantage over Wayne. And there were other scientists that, I don't know if I'm supposed to mention that I was on Wayne's nominating committee.

HKS: I won't tell him.

DM: Huh?

HKS: I won't tell him anyway.

DM: Okay, there were three others that I was very happy to serve on their putting together the nomination for these people. Again, all of them had the same problem Wayne had. It's hard to

work numbers on certain things and this is what most people relate to quickly. You know, this is three times bigger than that. This is half again bigger than that. Or this five-inch storm gave us three inches of rainfall in this weir. So what? So many of these people who made significant contributions to forestry, very significant, long range significance to forestry, simply were not as competitive as let's say the individual who designed OSB board. That program took about four years for this guy from beginning to end, getting woodchips, gluing them together, pressing them together, and making instead of plywood, OSB board, and he received the Wallenberg. I mean it's something that you could actually grab. You could put your arms around that. It's very difficult to put your arms around forested watersheds.

HKS: It's hard for me to imagine a breakthrough in watershed. It's a very, as Buckman says, the building blocks of watersheds.

DM: Exactly right.

HKS: There's no quantum leap.

DM: No, no. And that's where they are at a disadvantage. The guys with these thirty-year fire plots, the same way, work just as hard, just as long hours, just as diligent as anybody else. It's just that no one knows about it.

All right, then I retired. Like I said, we were going to retire in '93. Pete the Greek, Pete Roussopoulos, asked me to stay on to help find my replacement and work with them as long as I

possibly could until I retired. I said fine. Living in that guest house, we lived in that guest house for nearly fourteen months. This house took a long while. Beaufort contractors are not known to be efficient and we fired like four of them, threatened to throw a couple of them off the dock. Shrimp boat going out a little bit late in the day. When I retired I figured well, I'm going to do a lot of fishing and a lot of laying around doing nothing. Well, within two weeks out of retirement January of '94 I'm getting faxes will you come give a seminar here, seminar here, seminar here and turns out that within three weeks after my retirement I had nine speaking engagements set up, dead of winter. Fargo, North Dakota, Minneapolis, St. Paul, University of Wisconsin, Chicago, and they were primarily the urban tree people wanting to know is there any way that we can incorporate this research that you did with tree seedlings into mature trees. Well, we put together, Selina and I put together homemade graphics if you will, slides. Keep in mind this was way before PowerPoint, which by the way, I still don't use. So I took off and flew up there. Got caught in some damn white out blizzards and everything else and spent eight days up there lecturing. And it became very obvious there's tremendous interest out there. A point that I want to make, I want to be sure that this is clearly identified. All the mycorrhizal research worldwide, worldwide, I don't care if you're dealing with cotton, corn, soybeans, or pine trees, was based on seedling research. I published the oldest mycorrhizal paper when we published eight-year growth data in the field on some studies we had here in the South. But everything started off with inoculating a seedling. Now all of a sudden we look around and we're seeing this giant landscape industry. We're seeing these very significant tree care companies who are not only taking out dead trees and taking out dead wood out of big significant urban trees, but fertilizing and everything else. So we started doing our homework on urban tree business and Don Ham, Dr. Don Ham at Clemson, Duke graduate, going way back to the '70s he used to come over from

Clemson to the lab in Athens and he said, Don, when are you going to do some work with urban trees. I said I'm not interested in the individual tree. We're dealing with plantations of trees. I just don't have the mandate to do that. Well, then he came during this discussion when we were trying to look at urban trees. He said one urban tree, Don, is worth ten acres of plantation. That oak tree out here is worth a hundred thousand dollars as far as this landscape is concerned. Started looking into that and started giving talks to these companies. In 1995 I gave a hundred and fifteen presentations, averaged four a week, leave on Monday, come home on Saturday, take off on Monday, come home on Saturday. Did this continuously to drive. That's when we put the company together, trying to find out first where the needs were, what's missing, and could we answer it. In 1994 the International Society of Arbor Culture, ISA, sponsored their annual meeting in Hilton Head. Selina and I read about it in some flier. At this time when I retired from the Forest Service, Ed Cordell had retired the year before me, we went to work part time more or less for Mycorrtech, this Steve Maul I mentioned, they were producing Pisolithus in a plastic bag, and he said can you come work for us, you know, work on commission, whatever and everything else, because I'm putting two horses here together. So we started looking into this urban forestry deal and found out that these ISA conferences always have a tree-climbing contest. These young guys are out there swinging from branch to branch, incredible athletes, and it's a contest. We now have world champion tree climbers. It's not like topping a big Douglas fir like you have out West. These are yard trees that people are swinging back and forth on taking that dead wood and earn their profession doing that and very skilled and highly athletic people, men and women. When we built a house here they put in a drain field and they did severe root damage to some of my trees, severe root damage. So I got on the phone and told my technician the next time I was in Athens I him to give me a couple of pounds of PT spores that we had

collected years ago, because no one is going to use them, you know. So I came back here and just inoculated the trench that they had filled in with spores of Pisolithus just to see what would happen. And I put in root in growth cores. This is a technique I developed for this global climate change thing where we would remove a core of soil of that dimension, screen it to get rid of the roots, put this in that hole, and fill that with root free soil.

HKS: That's about two and a half inches in diameter?

DM: Three by eight.

HKS: Three by eight.

DM: And then roots would grow into this and periodically we would get a knife and cut them off from the outside and we could measure root growth over various periods of times or whatever else. Well, this also where I put PT spores inside this root free soil, went out there after three months and cut it open, it was completely full of Pisolithus mycorrhizae just like a nursery seedling. I said holy crap, this is a three hundred year old oak tree and this is a fungus that everyone said it only works on seedlings, because they hadn't tried it on anything else. I said holy smoke. Well, we found out about this tree climbing contest. It was a great big old tree just like this one in Hilton Head. Contacted Don Ham and said where is this tree. He drew us a map and we went to this tree. We put in these cores four months in advance of the meeting and put different inoculum, Pisolithus in here, and some controls, and we tagged them and they're buried. Four months later, I dared not look at them. I didn't want to cheat. Went back to the

meeting four months later. During the course of the meeting I met with Don Ham and he introduced me to several key people. One is P. S. **{??? Flores 294}** from Holland who had a big successful tree business. He is now our representative in Holland for the company. And all these other people come in. It's hot. It's a hundred and five degrees, miserably hot. Went out there underneath this tree after the climbing had been done and we found all the cores. We had put about sixteen of them around or something like that. Selina and I went out and we found them all in there presence. Said here, now here's a tag. This is inoculated. This is a control. Now you guys take your pick. Which one do you want to take a look at first? Said well, let's look at the controlled. So I had this big filet knife and I dig around and pulled it out and we had a screen. We screened all the roots that were inside this and it was a thimbleful. Take your pick. All right, let's take this one that says spores. See the photograph over there with Selina's hand?

HKS: Uh-huh.

DM: That's the first rake we emptied. Thank you, Lord.

HKS: It works.

DM: It worked. For the first time ever in the history we were able to successfully inoculate a mature tree in a manmade landscape and that opened the company. We then developed products where we could inject the root system of declining trees and we confirmed all this with research papers, publications from '94 through '99. We're still doing research, just publishing it in different journals, tree care journals, the Journal of Arbor Culture. Working instead of university

people we're working with **{??? Barclay 324}** Tree Expert Company or Davie Tree Expert Company, the world's biggest tree care company, urban tree managers. It worked. Now in addition we inoculated trees, reclamation.

All right, about the same time I get a call from a guy that I have been corresponding with off and on in the Forest Service the last two years of the Forest Service begging me to come to Salt Lake City to look at Kennecott copper mine. It's the largest open hole in the world. Well, when he was calling back when I was in the Forest Service I was out of that work. I was tied up with air pollution and all this other stuff. I simply didn't have the time to address it. Well, he called and he said well, you're retired now, can you do it now. I said yeah. His name is **{??? Lynn Morris 340}**, tough old acid rock miner, right, engineering with revegetation background. He said I want you to come out here. You and Ed Cordell come out to Salt Lake City, our guests. We'll buy you a plane ticket and all this other stuff, and we'll pay hourly wage, whatever you ask, to come out here and take a look at our problem. We want a presentation of what you're doing, what you have done in the eastern United States, and we want then for you to speculate as to what you might do out here. Well, Ed Cordell and I go out there and we're in the middle of the damn desert. The mines are seventy-five, hundred feet elevation. And here they've got some out slopes that have burned since 1890, right? I said well Mother Nature did a fine job of revegetating this damn area. He said well, that's why I'm here and that's what we do. Our reclamation program is we bring in three foot of topsoil and cap it, just like we were talking about yesterday, and then we direct seed it. We use Osmocote fertilizer, a ton per acre. A tremendous cost. End up after three years they have "successfully" revegetated the area at the cost of seventeen thousand dollars an acre. Well, a lot of that, of course, is taking the three one slope and making it a two

one slope. Some of those slopes are pretty severe, everything heavy equipment. You ever seen a D-18 crawler tractor?

HKS: No.

DM: You couldn't put it in this room, unbelievable. So we went out there and met with all the bosses and Lynn. Gave a presentation, and then we spent two days looking over the site and I told them flat out, I have no earthly idea. I said all the research we've done is in areas of forty inches of rainfall minimum. You guys get eight to ten and it's in a four-day window like thing and we're dealing with plants we have no personal experience with. There's not a heck of a lot experience on four-wing salt bush and Indian bush, Indian and all these other native desert plants, sagebrush and that, because we had done our homework on literature search just to find out what we could find out about them, nothing. He said well, we know that. We want you to start from the very beginning. So we put together a strategy. There's the report for 1997 right there.

HKS: Big, yeah.

DM: Oh, monthly reports, more bureaucracy than the Forest Service. Anyway, he said I want you to put together a budget and a research plan. I said well, the research plan is easy. We did that last night in the motel room. It was very logical. First thing you got to do is to find out what's native, what native fungi you have in the roots and this type of thing. Of course, all the plants out there are endo-mycorrhizal, very few ecto-mycorrhizal trees. The only one is the oak,

what the heck, native oak out there. I forget what it is. That's an interesting story in itself. Put together the plans for our budget. What are you going to charge us? I haven't the vaguest idea. I've been Forest Service. I haven't been in the private sector. He said well, I'm not going to tell you, but he listed a price per hour that covered also our travel time in the air. Fifty percent of that time was office time. I mean cut the field time in half, the hourly wage in half, and I'm sitting here looking at this money I said is this real. He said look, he said I know you guys are government. You haven't had any experience in the private sector. He said but this is what you're worth to us. Okay.

HKS: You could learn to live with that, huh?

DM: Yeah. I said wait a minute now. You have to realize I'm sitting there stretching that nickel, I mean that penny. I can get a penny and make fifty miles of copper wire out of it. I was so cheap in the Forest Service. I said now wait a minute. We're going to have to be out here probably five or six weeks. He said that's all right. I'm sitting there ching, ching, ching.

Tape 7, Side B

DM: He had investors, of course, to form the company and everything else. Steve Maul is a brilliant scientist. He's a graduate of MIT, incredible scientist. He had the vaguest idea how to do business. He still works for us today. He still works for the company. We ended up buying the company and that's another story. So we get out there and we put together this plan. I came back and I told Selina I said look what the hourly wages. Wait a minute. You're going to get paid so

many dollars an hour to work the office here, damn. It was a primary source of income for Mycorrtech, which was the company we were working for, Steve Maul's company. Well, the deal we made with Steve Maul was this is money Ed Cordell and I are earning. We're going to keep it. We'll purchase the inoculum from you and all this other stuff, you know. Well, it got to a point that there was no way that that company could survive so Ed Cordell ended up giving him all the money and we went on salary for seven hundred and fifty dollars a week. Like I said, we'd kept the money, kept the company alive because we had six or eight employees and there was no other source of income except what Ed and I were doing. It had nothing to do with the inoculum of Pisolithus. It was this consulting we were doing. Well, the long story short is that we hit home runs. There was no source of mycorrhizal inoculum of the fungi that formed eighty-five percent of the mycorrhizae in all the world's plants, VAM, vesicular arbuscular mycorrhizae, the endo-mycorrhizae. There was no inoculum source available. By coincidence a young scientist I worked with in Brazil who was producing in Brazil mycorrhizal coffee, red fruit, and the various other plants that he sold with his company to growers. He didn't sell inoculum. He just sold the inoculated plants and it was successful. When I was in Brazil in '86 I saw his operation. Dr. Ming, M-I-N-G, Lin, L-I-N from Formosa. Brilliant guy, and typical of those people, forty hours a week was part-time. They worked forever. Well, just by coincidence he ended up working in Texas with Formosa Plastics, big plastic bag producing company, one of the large producers of the plastic that they use to make plastic bags with. And he was put in charge of their environmental group to have a lab on environmental monitoring because they, Formosa Plastics, wanted to prove to the community that they were not contaminating the environment and this type of thing. And Ming put together a very, very effective program on environmental monitoring and he also produced a bunch of inoculated trees and he created parks, planted park

trees for these people. And I had heard that he was producing VAM, endo-mycorrhizal fungi in a crude way in his lab so I flew over there and looked at it and talked to him. I said we're going to be needing some of this stuff. He said well, we'll produce it. However, long story short, he produced the inoculum that I needed at Kennecott Copper, which is ninety-nine percent of the plants we work with they formed that type of mycorrhizae, rather than the ecto-mycorrhizae we have for pines. And we got plant response like you wouldn't believe. Sagebrush, Indian paint brush, four wing salt bush, indigo bush, all these native plants. We also obtained native mycorrhizal fungi from the roots of these plants in native environments, tested them. Turns out that the cocktail that Dr. Ming and I had selected earlier was more effective than the native species because the soils we're working on now has no resemblance to the native soil, mining waste. But we went in there with a municipal bio solid program. We negotiated with Provo, Ogden, and Salt Lake City and got all of their municipal bio solids hauled free to the mine site and saved the taxpayers of Utah seven million dollars a year in how they can dispose of the municipal bio solids. We got it freely donated and we were able with the yearly production of bio solids we were able to do about two hundred acres a year. That was later after we did all of our R&D, the research and all this other stuff. The thing about it is, we did some magnificent research, got some incredible results, and we could never publish it.

HKS: Oh, yeah.

DM: Because it's proprietary information. We are now—

HKS: Does that bother you as a scientist?

DM: No. I don't need any more publications. We are free to discuss our results but we're not free to discuss precisely how we did it, where, and all this other stuff. I mean there's no problem with Kennecott Copper. Well, the thing that's amazing is that **{??? Lynn Morris 058}** who's been a reclamation engineer in hard rock mining areas from uranium dating back to the '60s, he's my age, saw the results we were doing and he said this is the most amazing. He said he knew, he'd heard unknown to Ed Cordell and I he had attended some of our reclamation conferences and we give presentations. This is why he ended up calling us. He said this is the most amazing thing I've ever seen. I want to be part of it. By this time, this was 1997, we had formed Plant Health Care, Inc. We absorbed Mycorrtech, their stock. In '95 we put Plant Health Care, Inc. together, brought in a CEO and president aboard. I was chairman of the board, chief scientist, and got Ed Cordell, Steve Maul, and a young guy by the name of Mike Kernan who is a key man for me today, Dr. Mike Kernan. All Ph.D.s. And I learned very quickly, Pete, do not put in charge of a company a Ph.D. That's a disaster unless the Ph.D. is in business management. We made some stumbles along the way. You know it's important you can have the solution to a world's problem but if you can't market it and sell it what good is it. Our problem was that we could not grasp that aspect of it because what we tried to do is to continue doing what we had done in the Forest Service. First priority was education. We realized that people had to be educated in this technology because most people can't spell the word mycorrhizae anyway. So we started writing articles for any journal that was submitted. We were getting requests from journals please write an article on mycorrhizae. The first year we published like twenty-five in trade journals, very generic, very simple, not scientific. There's a bunch of friendly fungi out there to do all kinds of good things. And we were very much in demand, getting an invitation to all these conferences

and trade shows. Like I said, 1995 I gave a hundred and sixteen presentations. I mean if there are two guys at a urinal I give them a lecture. I mean whoever would sit and listen, whoever wanted to listen. Again, long story short, **{??? Lynn Morris 087}** said, we were sitting in a motel room outside of Salt Lake City right next to the mine with a fifth of Jack Daniels smoking cigars. We'd just finished a hard week and the results were incredible. We'd just put together, we had the numbers to put together the final report to eventually give the presentation to Kennecott Copper. He said I want to be part of this. I said hell, we'll do better than that. You are now president of PHC Reclamation. We created a job right there on the spot. I hadn't got permission from the board or anything else but I knew this was it. This guy had a network all over the world when it came to mining. And we toasted that, it happened, and he was successful in putting together PHC Rec from his bootstraps, if you will. The only contact we had was Kennecott Copper. That was 19, he became president I think in 1997 and unfortunately he died two months ago from cancer, horrible. Fortunately for us he was sick long enough to know he had to bring a replacement in and he recruited a young man he had worked with for years, Chris Waller. I'd like to have that name here, who's now president of Plant Health Care. They do very significant contracts. We won the People's Choice Award. We're doing reclamation, mine land reclamation, and we're actually building a park for the state of Wyoming in an old gravity gold mine, water gravity flow. We're reconstructing the entire operation for a park. Of course, we have to cover up fifty deep mines, you know, this type of thing.

HKS: You bring in landscape architects and all the rest?

DM: Oh, yeah, we do everything. We do it all. We then opened up the number one priority, you have to realize mine land reclamation came later. We were developing product for tree care, established tree care, transplanting, and my job was to develop all the products and test them. And Ed Cordell was working on reclamation and I was working with other aspects of the company, developing products, transplanting tree shrub, ball and burlap. I mean some awful big trees, four-foot diameter trees with a thirty foot by thirty-foot diameter root frame, moving them successfully, inoculating root systems to repair damaged roots with the mycorrhizal technology and bacteria. We also brought in **{??? Rhizo 120}** bacteria, beneficial bacteria that makes atmospheric nitrogen and solubilized phosphorus. We've got research behind all this stuff. And we have our facility that packages all these products is in Pittsburgh and this is where Steve Maul was Mycorrtech, old Shell research center that the University of Pittsburgh opened up for businesses to come in and this is where we got started and where we still are today. We moved the facility out two weeks ago to another location but the office is still there. But long story short, over a period of from 1994 through now we have some forty products. Anything that's got a green top we've got a product for; trees, shrubs, flowers, forbs, grass, sports turf, agricultural products, gangbusters.

HKS: We've had our yard landscaped by professionals, including moving some things around, yucca plants here to there. They said the only thing we can't move successfully is creosote brush. It just does not transplant. It dies. We'll move it for you but there's no warranty.

DM: Next time you try that let me know. I'm going to send you some stuff out to give it a shot. Never tried a creosote bush. We've never had a failure yet.

HKS: At our elevation, Las Cruces is about four thousand feet.

DM: I know. Well, you need to call John **{??? Mexel 138}**. He's got a study on green ash right now on campus with our stuff. That did go in didn't it? It didn't go in?

SM: Not yet.

DM: Okay. Anyway, we went through some bumps on the road, changes of management. We now have a very significant individual who's CEO and president of the company. I'm still chief scientist and one of the executive directors. John Brady, incredible human being, incredible leader, businessman. Last July we went publicly traded on the Aim Division of the London Stock Exchange. We have, like I said before, in the Forest Service I worked for two hundred and fifty million shareholders. I now work for about a hundred and thirty, still with the same mandate, do your job. We're in Mexico. Very successful operation in Mexico that started out with forestry to reforest severely burned areas and that eventually expanded into agriculture because I was developing an agricultural technology here starting in 1999. Local farmers here were using it, where the fumigated soil, planting a tomato plug growing in the greenhouse. We inoculated that plug in the greenhouse into fumigated soil. We increased tomato production by twenty percent. Returned to the farmer up to four thousand dollars an acre and it cost him eighty. We did it Alabama, Florida, South Carolina, North Carolina, all over the place over a period of a couple or three years, so that became our agricultural mandate until we acquired this company that produces root stimulate that I told you about, this chemical. When we went public we were able

to generate some funds to start looking at acquisitions of companies that paralleled us. In today's marketplace there's very little successful single product company. I don't care if it's penicillin. So what we did looked at companies that had natural technology because that's our theme of our company. We are putting back into manmade landscapes natural systems that allow plants to maintain health and vigor. It's that simple. And like I said, it doesn't make any difference if it's a PGA golf course or trees on a golf course or shrubs or flowers on a golf course or the turf itself, or a tree in what's that landscape in London, Selina, the arboretum?

SM: Kew?

DM: Kew Gardens in England. Anywhere in the world, we've got a dock builder coming down. That's not Mickey is it? [Laughter] Sugar, he's going to edit all this out. I'm assuming he's going to take all the damns and hells out of that thing. But all during this time we worked with Salt Lake City, Utah through 1997 averaging about four or five weeks a year there, making sufficient funds to fund the rest of the company, that we're developing all this other technology for our landscape plants, establish trees and that. It's amazing, you know. One thing I learned in the Marines, the guy with the machete cuts the first path through the jungle makes it awful easy for the guys second in line. Well, we cut the path through the jungle with our technology. We introduced a technology that didn't exist nowhere and established vegetation. Our technology started with tree seedlings. Now we've opened up a market that was ready to absorb it, ready to accept it, once they saw results, of a technology heretofore unknown for them and we created that marked with Plant Health Care, inoculating mycorrhizal fungi, both the ecto and the VAM, the endo, by that time we had the endo from Dr. Lin, and the **{??? rhizo 199}** bacteria plus bio

stimulus and various other things. Palm trees, everything with success. We now have a staff in Mexico, Holland, the U.K., Spain, and PHC Rec, of course, but at each of those countries they service about six or eight other countries. It's just like our salesmen in the United States, they may be headquartered outside Atlanta, Georgia, but they got Alabama, South Carolina Georgia, and North Carolina, and Tennessee as their region. We have about forty-five, fifty employees worldwide. We're financially profit making. We have investors standing by to invest whenever they feel the notion. Thing about it is I can't say too much about it because I'm one of the executive directors and we're publicly traded.

HKS: Is now the time to buy shares, insider?

DM: I cannot interact with that.

HKS: Okay.

DM: Especially on a damn tape recorder. But it's been a helluva ride. Like I said, the horse stumbled and fell on us a couple of times.

HKS: I can't remember the name of this mega agricultural operation in Minneapolis, nationwide, does all sorts of things, fertilizers and so forth. It seems to me you'd be a target of takeover from one of these big guys. You'd make a great division.

DM: If we're lucky.

HKS: Huh?

DM: If we're lucky.

HKS: If you're lucky?

DM: Yeah. We are working with some extremely large companies. I am able to talk about this because this has been publicly announced. Miracle Grow, Scott's, came to us two years ago said we're interested in developing a natural product line for plants and we have looked everywhere in the world and your company's the first one keeps coming out on top of everything we look at. Is there any way that you guys could work with us to develop a retail line? No, right? Well, this is off record now. We found out that the public, their public, which is by the way, eighty percent female buyers, were very, very receptive to a natural product line, not to throw Miracle Grow out the door but to work in concert with Miracle Grow. Well, we will have the first products on the market next year, 2006. We're looking forward to that.

HKS: You said that little packet's called EcoGrow?

DM: EcoSense, that's what they decided to call the product line. Now that's just a sample. The one I'm very happy with is that our company, Plant Health Care, will be stated in their technology for plant [one word inaudible] **{??? purity 248}**.

HKS: **{??? several words inaudible 249}** company?

DM: No, no, no. No, I'm not that cocky but no, just to make sure a company is recognized for the technology because again, like everything else, there has been so many people been involved in doing what we've been doing.

HKS: Is there difficulty patenting something like that?

DM: No, you can't, too much public information, too many publications on it. You can patent a process but you can't patent what does the process. We have with this chemical that we put on agricultural seed, it's called, trademark name is Myconate, M-Y-C-O-N-A-T-E. Some of the products that we develop with it is called colonize, meaning it colonizes the roots and this type of thing. That's protected by three patents, but we acquired that from Michigan State. We pay a royalty to Michigan State. Every time we sell a dollars worth they get five percent royalty because they're the ones that funded the program to start with, to try to get their taxpayer's money back, which is fantastic. That's the way it should be. But right now, for your information, we have worldwide sixty-three experiments on agricultural crops, seed treatment of this product twenty-five grams per acre, in South Africa, Australia, Argentina, Zambia, Zimbabwe, France, U.K.

HKS: I'm trying to visualize spreading twenty-five grams over an acre.

DM: You can't. You've got to put it on the seed. Corn, for example, is about twenty-five thousand seed per acre and we put one milligram per seed. That's twenty-five grams. And, Pete, we're seeing independent research we did with third party testers, we contracted professional agricultural researchers to test it for us. We just produced it; they put it out in the field for us, measured it and everything else. Okay, we increased soybeans by twelve percent; corn up to twenty-two percent. With a good year the controls were producing a hundred and ninety bushels per acre and we produced over two forty.

HKS: You're reminding me of Norman Borlaug's—

DM: I know Norman.

HKS: Absolute genetic strength.

DM: Yeah. All we're doing is putting back what normally occurs in natural landscapes but what does not occur in manmade landscapes. We're just putting it back. There's nothing remarkable about that, right? It's common sense. We know what's missing from most of these landscapes. We know that in nature this tree is now an urban tree, isn't it? But for the first three hundred years of its life it was a forest tree, never fertilized, never irrigated. Wow, how the hell did that happen? How does that tree continue to grow without fertilization, without irrigation, like we do in manmade landscapes? It's because these microbial processes allow it to persist in this native environment because of these supporting elements, these microbial partnerships that are associated on the root systems that are missing in manmade landscape or at least seriously

depressed, and this is what we found with our research, so let's put them back. That's all it is. My talk tomorrow, I'm leaving here at five o'clock, like I said. I'm giving at talk at Gwinette Tech outside of Atlanta. They teach horticultural students and there's going to be some twenty that are going to work with it but I'm going to first, my first photograph. That's the angel oak out of Charleston, South Carolina. It's a fourteen hundred year old live oak tree, nine-foot diameter. It's now a park tree. The first fourteen hundred years of its life it was a forest tree. In order to make it a park tree we modified the environment completely. The tree is now dying. The main reason is because the carbon allocation and various other things, compaction. This is the borrow pit in Aiken I was telling you about. These trees right here are twenty-two years old, the same age of these trees back there in the back. The ones in the back are growing on natural forest soil. These are growing on what's left after they removed twenty foot of topsoil to build something with. I don't know why they call it a borrow pit because they have no intention of returning it, right? All right, these trees are fertilized every other year, thousand pounds of 10-10-10 and a thousand pounds of dolomite limestone. That's all you have to do, right, is throw the fertilizer on them? Well, they get rainfall, fifty inches a year here. See how prosperous they are? When the fertilizer does respond the roots are as deep as they planted them with a planting machine right there, six inches deep. Can't penetrate anymore because the soil is like this. The tops respond. The wind blows them over. We go in, we rip the soil. That's Dr. Paul Karmatic right there. Rip the soil like this, add municipal bio solids. Sub soiling had a tremendous impact on the root penetration. We did three things. We changed the physical, chemical, and biological aspects of the soil or we did only two of those or we did only one of those. Where we did all three, you got the big trees. Where you did one or only two, eighteen years later, Selina and I went back to this site last year, this is a controlled plot, fertilized every year for the first five years with 10-10-10

fertilizer, dolomite limestone, but did not have the mycorrhizal management or it did not have an organic matter source. Eighteen years. Next photograph is where we had all three of them done right.

HKS: Looks different, yeah.

DM: Municipal bio solids were applied one time, a half-inch broadcast mechanically incorporated in. One time in eighteen years and the effect is still there because it's recycled.

HKS: The natural way. Get it started and it takes care of it.

DM: That's right. Now getting back to what I was talking about, this is where it all is right at the top, twelve inches of soil. The organic matter, the forest floor, the organic matter, recycling, all the root system, the microbial dynamics and all this other stuff and that's what basically the theme is. We're putting this back. Whether it's a mine site or whether it's an urban tree in your back yard, we're recreating this forest soil profile where all the microbial dynamics and all the mineral nutrition, organic matter, decomposition, everything else takes place. That's what drives, this right here is what drives all forest ecosystems right here. And all we're doing is we have found components of that that we can manage the bacteria, decomposing bacteria, the **{??? rhizo 381}** bacteria that live on roots, the mycorrhizal fungi, we can now mass produce those and put them back where they're missing and the results have been very rewarding.

Here's a copy of my notes here. You can take these with you.

HKS: That will help.

DM: The big thing is the chronology, my best recollection and best records are close enough here I guess. There is life after the Forest Service. How long we're going to stay doing this, we've been doing it now for ten years. Still having fun. Like to slow down on travel. My main responsibility is product development and testing. I'm in charge of technical services for the company and have four PCs, one in Austria, who is our bacteriologist. All of our bacteria have DNA signatures on them. We can go out and add them to a soil, come back and sample the soil and run DNA on it and tell if they're there, using state of the art technology, which is expensive. But that's what it takes to be competitive. We have a very significant, even though there are other companies that have followed us, now competitors, that have basically copied our website and just changed the name of the products. Very unethical but they do it and get away with it. We still have the significant market share. We are in, like I said, agriculture, grow crops and vegetables. Our studies we're having this year are with the seed treatment is soybeans, corn, cotton, pinto beans, potatoes, sorghum, milo, anything like that. We're going to be involved—

Tape 8, Side A

DM: We put together a cereal production program for Iraq and Afghanistan, which we are readily willing and able to do. All they have to say is do it. We should be actively moving this seed treatment program forward rapidly next year. We're working with several large companies

I'm not able to name at this time because of confidentiality agreements that are very interested in worldwide distribution of this chemical for seed dressing.

HKS: If you decide to go fishing more are ample scientific skills available and you could say this guy could do the job I'm doing, not depending upon Don Marx for success anymore?

DM: That's all part of what we've been planning for the last year. Hell, I could be in a plane wreck. First of all, no one is indispensable. It's just a matter of who's going to be here to carry on, you know, sail the course. I would like to think that I'm going to be available for some time. I don't plan on being in a plane wreck. I don't know if I ever want to quit completely. You have to realize this has been my life since 1958, both Selina's and my life. Met some fascinating people. Worked with some interesting people, have seen the world. Have worked in the world. No regrets, none, zero regrets. Wouldn't do any damn good anyway, would it? My dad told me years ago, son, you never learn anything new by being kicked by the same mule the second time. Huh? And with the Forest Service that was a mandate. You don't make the same mistakes twice. Same with our company, don't make the same mistake twice. First, recognize that yeah, this was a mistake. We just can't do that again. Now it's more financial than it was with the Forest Service because with the Forest Service you were spending somebody else's money. With this company we're spending our money, shareholder's money, investors' money, and it puts a different spin on it. The purpose is to persuade our clients and not necessarily other scientists. Ninety percent of the people that read your publications in the scientific arena are other scientists. Rarely are the scientists users of the technology, and I recognized that real quick as soon as I retired that technology transfer is a mandate now, right? We have to be able to

communicate this technology and other technology associated with it to a client that doesn't even know what fungi are. To them fungi are bad; they cause disease. They cause athletic foot. And now you're saying we're going to bring in deliberately these fungi? Well, you first got to let them know that the biggest fungi out doesn't normally occur. It's all part of the educational process. All of our salesmen have a practice presentation on the basic fundamentals of life, photosynthesis that produces all the organic carbon that's you, all the oxygen that we breathe, from the basic fundamentals to how do these trees, plants, survive and grow, sustain themselves, the natural soil processes. This is what we're doing and so and so. That's the way they package the entire deal and it is extremely successful.

The workshops taught here are not only for clients and potential clients, but for all employees. We have what we call the PHC University. Once a year every employee goes to it and we go through everything from start to finish. This is a fungus. This is a bacteria. This is how we mass produce them. This is how they are in our products. This is what this product is for. This is the application in this product. This is how you apply it. This is the anticipated result. No one is uninformed. We're not selling snake oil. There is a concrete base for this technology and every salesman, none of them are Ph.D.s, most of them don't have college training, but they have personalities. One thing I learned quickly, you can have the smartest person in the world working for you but if no one wants to be around them, I don't think you want to put them in a salesman's position. A salesman is somebody who you want to be around. You don't have bad breath. You know, you don't have bad habits. You want to be associated with this person and then once you are associated with them I'm going to pay attention to what they say. So we look for

personalities first and then we can train them in the technology. And we have been basically far more successful than we have failed with these individuals.

HKS: George Staebler, you may have run across him. He was head of Weyerhaeuser's research program early in the game.

DM: Who?

HKS: George Staebler.

DM: [Laughter] Yeah, I know George.

HKS: Great guy.

DM: Yeah, sure. In fact, he gave permission for John **{??? Mexel 064}** to work with us when John **{??? Mexel 064}** was in Arkansas.

HKS: George told me he said the big difference he sees in Forest Service and university research and corporate research, your corporation, if you're more than fifty percent sure it's going to work, let's try it.

DM: You damn right.

HKS: And you try it. There's real money involved here and the private sector is much more willing to gamble than the government is.

DM: Risk takers, the biggest risk is not taking one. There's no question about that. Like I said, you never want to put a research scientist in charge of a company. I jokingly tell all of our people that every scientist five seconds before he dies will say all I need is one more study! Right, forever. Well, sooner or later, like when we did our breakthrough with Pisolithus we had to wade through all the nay Sayers. There's too many unknowns out there. All the pesticides in the nursery, all the high fertility in the nursery is going to inhibit your mycorrhizal development. I said go look at those seedlings now in that nursery. There are abundant mycorrhizae on them. How come they're not inhibited, right? Well, nobody had bothered to look at these seedlings in the nursery to find out what complement of mycorrhizae they had. We're finding it everywhere. So the biggest risk, like Bob Dickerman said, Don, the worst you can do is fail. Go for it. And okay, but we went against major advice from significant scientists saying you're wasting money; you're wasting a couple of years here. You know, get back to the lab. Thank God we didn't listen. We took the risk and we won. It was a crap shoot and we had to settle it. And it was more or less, you know, again everything we did was new, but we had guidance based on other people's failures and some of our failures, so it worked out extremely well. We are just very, very fortunate. What else we got to cover here? You got some more questions I'm sure.

HKS: No, I've gone through my list. And one anecdote about the Wallenberg award since you are a computer fan. Jeff was telling me by email that the system has finally been simplified. Used to be just a tremendous workload and now you get a one-page nomination by email for all the

people for the Wallenberg award, and the committee looks at that and says we'll look at these, and then you get the big packet, rather than reading all.

DM: You have your first cut.

HKS: First cut, he says it's just—

DM: Then like your final six or something?

HKS: Yeah, or however many they actually.

DM: Like I said, I was always, even after I got the award and was involved in the, Sugar, give him a copy of this thing we put together please.

SM: He can just have that one. I have it on the computer.

DM: Well, make him a copy please.

SM: You need one too?

DM: No, I got one. That's mine right there.

SM: Okay.

DM: Was never able, no one would tell you anything. The Wallenberg committee when I asked them in Sweden, that's confidential, Don. Just accept it with great humility and don't worry about who nominated you, and never was able to find out. Well, then we got involved in the nomination of some of these other guys and still wasn't able to find out exactly how it was done. Of course, the last one was, the one I really got deeply involved with was about four years ago and unfortunately he didn't win.

HKS: Of the three Wallenberg's that I'm aware of, you and Kirk and the geneticist at N.C. State, I forget.

DM: Gene Namkoong

HKS: I never did meet him though.

DM: The thing about it is, tremendous physical specimen. He was a ying-yang type, you know, very logical. When we went to meetings together we'd go to the gym and work out together. We'd run together and all this other stuff, tremendous physical specimen.

HKS: My interpretation of this is well, time lends itself to breakthroughs as we talked about before but someone does a lifetime of silvicultural research is too general.

DM: Gene had a unique area he carved out for himself. I guess the best way of defining it is population genetics. He put it, heavy statistics but he was able to present it in a simplified manner that makes sense to the average person. Unfortunately, Gene died two or three years ago, some strange disease, never found out the details of it. Have you ever met Kent Kirk?

HKS: No, I will July 14th or something.

DM: Kent's a nice guy. He and I went to N.C. State together, worked under the same professor.

SM: He dresses a lot more stylish than we do. [Laughter]

HKS: How does someone in plant pathology meet with an enzyme guy?

DM: I'm sorry.

HKS: How do you as a student in pathology meet Kent Kirk who is over with enzyme destruction and stuff?

DM: He was a plant path at N.C. State but he got a minor in biochemistry like I did. But he went into the enzymology aspect of it and I went into plant response to it.

HKS: Okay. He did a post doc in biochemistry in Sweden.

DM: Yes.

HKS: Sixteen months or something.

DM: At least sixteen months, yeah.

HKS: I think I'll turn this off. The transcriber is going to have my head with us chewing here.