

Bombs Away!

Reforestation inaccessible regions from on high

By JANET RALOFF

They talk of payloads, premission photogrammetric reconnaissance, inertial navigation, satellite positioning systems, and the aerodynamic shaping of bombs. There are discussions of employing idle commercial or military aircraft, and at least one person has experimented with surplus U.S. tanks.

Listening to recruits to this nascent international consortium, one might get the impression that they are planning some precisely coordinated military operation.

Instead, the aerial bombs they hope to deploy are open-topped cones bearing year-old tree seedlings. Their targets include denuded slopes, barren deserts, and war-ravaged sites around the globe—areas otherwise inaccessible to foresters.

Unless replanted, such soils are likely to erode with the winds and seasonal rains. Any water that falls risks running off instead of percolating in to slake the thirst of dormant seeds and soil-conditioning microbes.

The main impetus for this unorthodox approach to forestry, though, is concern about the growing buildup of atmospheric carbon dioxide and the threat of global warming it poses, according to Moshe Alamaro, mastermind of the as-yet-unnamed project.

A former aeronautical engineer, the Israeli immigrant has lately returned to academe as a doctoral candidate in mechanical engineering at the Massachusetts Institute of Technology. While a professed “gadget developer,” he argues that his curiosity about and comfort with new technologies is not what drives his zeal for aerial reforestation. “I was a farm boy and feel quite close to agriculture,” he explains. He also has been turned off by the many “ridiculous” ideas he has heard floated as possible cures for global warming—like seeding the ocean with iron or launching an atmospheric screen to filter solar radiation.

“Nobody is going to commit to such things without knowing definitely that global warming is under way. And by the time we know that,” Alamaro says, “it may be too late [to halt it].” He believes it is better to advocate “measures that are worthwhile to implement even if there is no global warming. And tree planting is one of them.”

His quintessential swords-to-plowshares scheme seeks to harness military

technologies—some developed for the Star Wars program, others refined since Operation Desert Storm—to protect Earth’s environment, especially in developing countries.

“Moshe has a genius for coming up with very complicated projects and then having the momentum to pull together a team of people to look at [the issues] from a lot of different perspectives,” observes Baruch Fischhoff, an experimental psychologist at Carnegie Mellon University in Pittsburgh. Fischhoff is one of the many people Alamaro has consulted, in this case to investigate social issues that could jam efforts to test or implement the tree-dropping concept.

Alamaro’s drive and infectious excitement are winning enthusiasts to his reforestation proposal. For instance, even though Frank Burch, the U.S. Forest Service’s reforestation program manager in Washington, D.C., says the idea “is not of great utility to our agency at this time,” he believes Alamaro’s scheme “is a neat concept, and I’m glad he’s doing this.”

Enthusiasm for the project has also come from supporters—many of them would-be collaborators—residing in Japan, Korea, the Middle East, South Africa, Britain, and Canada.

Worldwide, foresters tend to replant stands one tree at a time—by hand. Indeed, the West’s largest private landowner, Weyerhaeuser Co., based in Tacoma, Wash., takes pride in the fact that it plants by hand all of the trees on its 3 million acres in the Pacific Northwest.

That’s not to say that aerial techniques haven’t been used. Inaccessible mountainsides near Honolulu were reseeded by plane 70 years ago, after a fire leveled several hundred acres of forest.

Aerial reseeding also took off for a short time after World War II in U.S. mountain states. Eventually, notes Burch, “it was abandoned for a variety of reasons. A big one was predation.” Rodent populations exploded wherever the seeds were dropped, yielding fat mice and gophers but only the occasional tree.

Today, seeds can be coated with rodenticides to increase their chances of surviving long enough to germinate. However, commercial timber companies

Engineers are developing bomblets to sow trees in remote regions.

find that to maximize yields, they need to plant 1- or 2-year-old nursery-reared seedlings at precisely spaced intervals.

Robert Luk of Georgia-Pacific Forest Resources in Atlanta has a hard time imagining how aerial planting could control spacing. He suspects that although tree dropping might help stabilize badly degraded and largely inaccessible sites, it doesn't hold much promise for commercial timber companies.

Burch worries that there may be even bigger obstacles. "Our experience has been that even when you replant manually, if you don't train the planters well and closely inspect their work, you won't achieve high survival" because of damage to the seedlings.

He therefore has "trouble picturing how to put enough weight on a dropped container to auger it in at the proper angle to get a seedling established—without risking serious damage to the plant's highly vulnerable growing root tips." Over the past 30 years, he says, "our experience has shown that those growing root tips are critical to the success of reforestation operations."

Having pioneered the idea of aerial tree planting, retired forester Jack Walters has fewer qualms.

Now living in the United Kingdom, he spent 3 decades at the University of British Columbia, where he experimented with the design of bullet-shaped plastic plant pots to be mechanically driven into the soil. When he started, back in the 1950s, biodegradable plastics were only a dream, so he tinkered with perforations, slits, and folds that might let the pot protect a seedling during planting yet permit its roots to emerge later.

Though the novel pots generated worldwide interest, the idea never caught on with commercial foresters, he notes.

Undeterred, Walters went on to produce a rounded, polystyrene pot "that had fins on it—just as on an ordinary bomb." He grew seedlings for a year in the containers, then did the unthinkable: He dropped them from a height of 400 feet out of a U.S. torpedo bomber borrowed for the occasion.

Owing in part to his test site—rugged, mountainous terrain strewn with logging debris—"we didn't get a very good result," he recalls. "Only about 30 percent of the bomblets got into the ground and grew. Most of the rest hit rocks and smashed."

For another version, he molded the soil around the seedling into a block that narrowed to a point on the bottom, then inserted fins made from plastic cocktail swizzle sticks and girded the whole package with a plastic ring. "We froze these and dropped them from the torpedo bomber. And these," he says, "were more successful." When Walters retired, 10 years ago, he was trying to form wood

wastes into a fully biodegradable container for seedlings.

Throughout, he recalls getting little more than ridicule from most of his peers. "People in forestry don't take to innovation very rapidly. I was always trying to shake them out of their complacency—to bomb them out, I guess."

Alamaro has chosen instead to target the technology community for inspiration, support, and the financing of his tree-dropping scheme.

Among his first contacts was Japan's Ministry of International Trade and Industry, which has been developing a solar-powered, remotely piloted airship. Earlier this year, the ministry pilot-tested one such cruiser, which resembles an egg-shaped zeppelin with a finned tail. Designed as an inexpensive replacement for communications satellites, this vehicle can continuously ply the skies at an altitude of about 100,000 feet for periods of up to 2 years. Alamaro envisions using such an airship as his eye in the sky.

Fitted with high-resolution cameras, it would survey regions to be replanted, mapping rocky outcroppings and other inhospitable areas that should be avoided. By providing up-to-the-minute weather data, it could help identify that often small period of the year when soil moisture is high enough to encourage a seedling's growth.

The airship would also keep a lookout for people or animals that might be injured were a hail of 1.5-pound tree-bearing canisters to descend upon them at 200 miles per hour.

To help figure out how those canisters should be shaped, Alamaro enlisted James E. Kain of Andover, Mass., an aerospace consultant with several decades of experience working for the military. "I do bombs—smart bombs, smart munitions, and the guidance packages that go into them," Kain explains.

For years, he has also nursed an interest in reforestation. After hearing about Alamaro, "I realized here was a guy who had the same dream—reforesting by air."

With a little financing, Kain believes, he and Alamaro should be able to conduct wind tunnel tests on the aerodynamics of various shapes and drop the first seedlings in as little as 3 months. He anticipates using 100 canisters in 20 different designs to evaluate flight, placement, soil penetrability, and biodegradability.

Making this scheme viable, however, requires getting some 70 percent of the seedlings to survive at a cost of no more than \$1 per tree. In fact, Alamaro projects eventually planting trees for just "a dime or two each."

The key to keeping costs low and seedling survival high, Kain believes, will be the integration of some fairly sophisticated navigational and mapping systems into their flight-planning and canister-

delivery program. Some advanced military technologies can be used "to keep track of the land and release trees only where we have a chance of sustaining them," he notes.

Consider the inertial measurement units developed to keep track of a missile's movement. "We can take one of these, which are now on the end of a bomb, and put it in a plane. By marrying it with global positioning satellites, you can identify exactly where [the plane is] and the direction in which you are pointing."

By integrating information on wind speed below a plane, he says, "I can now drop our little tree bombs very precisely." He envisions sowing them with a combination of timing and ejection devices developed to disperse bombs in a controlled pattern for the destruction of runways.

The technology needed to couple all of these operations already exists. The problem is cost. Achieving the performance of existing systems on a shoestring budget will take some time and finesse, Kain admits.

Alamaro has asked a venture capitalist who recently retired from the Pentagon to go shopping for potential investors. Meanwhile, Alamaro's team has begun approaching government agencies, including the military, about financing for small-scale tests. If the scheme shows promise, says Alamaro, the organizations likely to entertain the most interest in aerial reforestry may be utility companies. Planting trees around the globe might be a way to offset their carbon dioxide emissions.

About half of the 7 billion tons of carbon that human activities spew into the air in the form of carbon dioxide each year increases atmospheric concentrations of that greenhouse gas, Alamaro notes. Sopping up this carbon would take a forest of rapidly growing pine trees covering an area more than twice the size of Alaska.

Not all deforested sites may be appropriate for aerial planting. Identifying suitable ones could prove challenging, notes Gabriel Schiller, a research forester with the Volcani Center at Israel's Agricultural Research Organization in Bet Dagan. "In dry lands, I don't think that something dropped from the sky, even with the best technology, can penetrate deep enough [probably 8 to 20 inches] for the roots to reach moisture and grow," he says. In more hospitable regions, including peatlands and sand dunes, though, "this just may work."

Indeed, Walters argues, it may have to. "If the establishment of large areas of vegetation is the answer to global warming, then I'm quite sure that the logistics of getting it done can only be achieved by the type of project that Alamaro is proposing." □