



TechLine

Information About Invasive/Exotic Plant Management

June, 2000

Wilderness and Rough Terrain Weed Management Possible

One of the greatest problems associated with noxious or invasive vegetation is that these aggressive plants can infest some of the most inaccessible, rough, and isolated sections of the planet. Public and private land managers must not only fight the spreading weed, but must do so in areas that are extremely rugged and difficult. However, innovative resource managers have met this challenge and developed new weed management techniques and tools that make rough country weed management successful and as economical as possible.

This issue of *TechLine Newsletter* details what these managers have learned and explains some of their remarkable equipment developments. These ideas may help you may develop your own methods for back country or rough terrain weed management.

Some of the most isolated and rugged terrain found in the U.S. is within designated Wilderness Areas. These locations are often rugged and contain weed infestations and no mechanical means may be employed within their boundaries. Yet they may be the crown jewels of all our public lands and invasive vegetation poses a particularly serious threat to these areas.

Yet, even in Wilderness Areas, weed management is possible and often very successful as several articles in this issue of *TechLine* detail.

"Keep close to Nature's heart... and break away, once in awhile, and climb a mountain or spend a week in the woods."

John Muir

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Largest Wilderness in Lower 48 Tackles Weed Problem

By Charles Henry
TechLine Editor

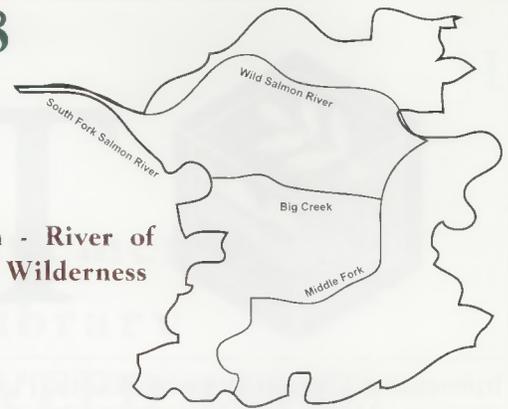
Within Wilderness, invasive exotic plants have the potential to transform natural plant communities into monocultures, altering floral diversity, wildlife habitat, recreation, and soil stability at the watershed scale," says Steve Morton, Regional Wilderness and Outfitter specialist for the USDA Forest Service (USFS) in Missoula, MT. "These wildlands are at high risk to invasive weed invasion particularly along rivers, streams, and trails. The vast majority of these landscapes still retain their native composition. However, discoveries of aggressive noxious weed species threaten to rapidly invade and displace native communities, permanently undermining much of the naturalness of the wilderness."

Morton says the challenge of wilderness weed control, besides the isolated, rugged nature of the terrain, is that motorized equipment is not used except in very rare cases. "By definition, the Wilderness Act (P.L. 88-577) mandates that the Wilderness be managed so its community of life is untrammelled by man, its primeval character is retained, and its natural conditions are preserved. Forest Service policy direction is to maintain wilderness in such a manner that ecosystems are unaffected by human manipulation and influences so that plants and animals develop and respond to natural forces."

"Some people question the use of integrated weed management strategies because they say this is manipulation," Morton explains. "But we feel restoration of native species is not manipulation; it is just preserving the natural condition."

Each Wilderness Unique

In the lower 48, the largest wilderness is the 2.3 million acre Frank Church - River of No Return Wilderness (FC-RONR). Based on the latest inventory, nearly 1,800 acres of rush skeletonweed, spotted knapweed, sulfur cinquefoil, Canada thistle, yellow starthistle and Dyers woad infest the wilderness. Concentrated along trails, river corridors, trail heads



Frank Church - River of No Return Wilderness

and on the roads leading to wilderness entry points, Morton says the weed problem in the FCRONR is still manageable if we move quickly. They are aggressively treating these transportation corridors with a variety of methods, he says.



Steve Morton, USFS Regional Wilderness and Outfitter specialist in Missoula, MT

"There is no doubt the weeds are beginning to move into the wilderness. If these plants were to become well established, we could lose 70% to 80% of the area's biodiversity. We are using manual methods, biological releases and backpack sprayers with Tordon* 22K herbicide, Banvel herbicide, and Transline* herbicide. In some places horses pack the water for the sprayers."

Morton says aerial applications would be an extreme last resort in wilderness areas so all the work must be done by hand and without motorized equipment of any kind. The key to this effort in the Frank Church is the mobilization of all the groups who use the area such as backcountry pilots, jet boaters, hunting outfitters, and private landowners with inholdings or adjoining property. In addition, the Forest Region is working directly with the Sierra Club, Wilderness Society, Idaho Conservation League, Friends of the Clearwater, and Wilderness Watch on a program where one or more of these groups would "adopt" a basin or stretch of river to help with monitoring and restoration. Half of the region's \$2 million annual weed budget is dedicated to wilderness weed control, according to Morton. "Getting ahead of the weeds is that important," he says. "Prevention of further infestations must also be a priority, with all visitors involved."

See "Wilderness" on page 4

Horseback Sprayers Key Back Country Weed Control Success

By Charles Henry
TechLine Editor

Frank Guzman, forest range specialist in Sula, MT, is charged with dealing with the Selway-Bitterroot “example” described by Steve Morton in the previous article. Guzman carries on the backcountry weed control begun by his predecessor, Tom McClure, who now works in the White River National Forest in Colorado (see article on page 4 of this issue of *TechLine*).

“Even though there are thousands of weed-infested acres in the Bitterroot National Forest, we still feel we can protect the Selway-Bitterroot Wilderness areas that are relatively weed-free through our efforts along trail and stream corridors,” Guzman says. “We have identified 15 canyons that serve as the primary trail accesses to the wilderness and areas in Idaho. We target spotted knapweed, sulfur cinquefoil and tall buttercup, and our goal is stop sources of spread.”

Horseback Sprayers

Guzman explains that because they work at times in the wilderness, they must use non-motorized equipment carried horseback. This equipment works equally well on isolated rugged terrain in the forest, too, he says. Today they employ battery-powered horseback-mounted sprayers to apply Tordon* 22K herbicide and 2,4-D. The Tordon 22K is applied at a 1 pt./acre rate with 1 pt./acre of 2,4-D. Originally powered with CO₂, this equipment was first used by Harley Bauer, Ravalli County weed supervisor (retired) and refined by Tom McClure and Tom Henderson, a local applicator.

Inspection of trails last fall that were sprayed earlier in the year showed outstanding control results, according to Guzman. “We like the results so much that we are expanding the program this summer to include more roadsides. We are also working to complete an EIS for aerial herbicide applications on winter elk



Frank Guzman, Forest Range Specialist, Sula, Montana



Panniers fit any pack saddle, are tough and durable, and present very acceptable eye appeal to hikers encountered on the trail. The applicator normally sprays from the lead horse. The rear mules carry only water for mixing that can be drawn from streams.

ranges and trails on the forest to restore native grass populations that were overrun by weeds.

Today, the Bitterroot Forest contracts with the county for the Tordon 22K so they do not have to invest in storage facilities. They contract with Henderson to do the application. Henderson uses a system that mounts two 5-gallon electric battery-operated sprayers mounted in Ralide Horsepac panniers. These units are totally self-contained and feature stainless steel ball lock disconnects pre-set pressure regulators. The herbicide tanks feature bottom drain valves and spray is pumped from each unit equally so loads stay balanced on the pack animal throughout the day.

“The panniers fit any pack saddle, are tough and durable, and present very acceptable eye appeal when we encounter hikers on the trail. I normally spray from my horse and lead two or the three mules. The rear mules carry only water for mixing so we can draw from

See “Horseback Sprayer” on next page

*Trademark of Dow AgroSciences, LLC
Tordon 22K is a federally Restricted Use Product

“Horsepack Sprayer”

Continued from page 3



Tom Henderson (left) uses a system that mounts two 5-gallon electric battery-operated sprayers mounted in Ralide Horsepac panniers (above). These units are totally self-contained and feature stainless steel ball lock disconnects pre-set pressure regulators. The herbicide tanks feature bottom drain valves and spray is pumped from each unit equally so loads stay balanced on the pack animal throughout the day.

streams. The Forest Service drops water from a helicopter in areas where we can't access surface supplies. And the units are easy to calibrate so operators know exactly how much they are spraying." (See Calibration on next page)

Public Relations Important

Guzman says they used this unit in the field 28 days last summer. They did not receive one complaint from the public. In fact, they received several compliments. But to keep herbicides as a tool, Guzman makes sure the public knows what he is doing. A forest service project inspector (PI) accompanies all spraying. This person also does GPS weed mapping and evaluation and talks with anyone they encounter on the trails. He also posts notices in the local paper and at each trailhead. Each ranger district receptionist on the forest

has a spray schedule so they can inform the public where they will be working on any given day.

Integrated Program

The Bitterroot Forest is committed to a complete integrated weed management program. In addition to herbicides, they make biological releases in areas that are too difficult to spray, use handpulling with volunteer groups, and aggressively promote weed free forage use. Because outfitters see the Forest Service spraying weeds along the trails, they have been more cooperative on the weed free forage program, Guzman concludes.

“Controlling the sources of spread in the highly used and most esthetically pleasing areas buys us a lot of good will. People wear shorts into these areas and they do not like walking through weed-infested areas and they want weed-free trails.” 

“Wilderness”

Continued from page 2

Other Areas Receive Attention

In the half-million acre Bob Marshall Wilderness, more than 208 weed sites have been inventoried. Each summer, crews travel the wilderness pulling weeds and making insect releases at these sites. Herbicide spray units mounted on pack animals have been used successfully for 10 years.

In the Cabinet Wilderness, crews employ handpulling and carry squirt bottles of herbicide to stay on top of the 20 weed sites identified to date. In the Custer

Absorkee-Beartooth Wilderness, weeds are not yet a major threat, but the Forest Service constantly monitors for their presence.

Morton says weeds such as spotted knapweed were first found in the Selway-Bitterroot in 1925 or 1927. “They pretty much have had their own way since then, so our strategy is somewhat different in that area. We concentrate on restoration after wildfires and containment where we can. This area serves as our motivation in the other areas. We can wallow in no-control arguments or we can get after the weeds. We say we don't want other areas to become like the Selway-Bitterroot,” Morton concludes. 

Backpack - Horsepack Sprayer Calibration

No Math Version

- Step 1:** Establish a calibration plot that is exactly:
18.5 feet wide X 18.5 feet long
- Step 2:** Spray the calibration plot uniformly with water, noting the number of seconds required:
Time Required = _____seconds.
- Step 3:** Spray into a bucket for same number of seconds.
- Step 4:** Measure the number of ounces of water in the bucket:
Volume Sprayed = _____ ounces
- Step 5:** The number of ounces collected from the bucket is equal to the number of gallons per acre the sprayer is delivering: Gallons Per Acre (GPA) = _____

Adding the Correct Amount of Herbicide to Tank For Liquid Herbicide Formulations

- Step 6:** Record sprayer output in gallons/acre (calculated from Step 5).
Output (volume) = _____GPA
- Step 7:** Determine volume of full spray tank.
Tank volume = _____ gallons
- Step 8:** From the herbicide label determine amount of herbicide concentrate to apply per acre.
_____ Herbicide per Acre (quarts or pints)
- Step 9:** Determine the amount of herbicide to add to each gallon based on the chart below.
- Step 10:** Calculate the amount of herbicide to add to each tank.
_____ Amount of herbicide/gallon X _____ number of gallons in a tank =
_____ Total amount of herbicide to add to a tank.

Spray Volume	Amount of Herbicide to Add to Each Gallon					
	Gal./A	1 pint	1 quart	2 quarts	3 quarts	4 quarts
15		6 tsp	2 fl oz	4 fl oz	6.25 fl oz	8.5 fl oz
20		5 tsp	10 tsp	3.25 fl oz	4.75 fl oz	6.33 fl oz
30		3 tsp	6 tsp	2 fl oz	3.25 fl oz	4.25 fl oz
40		2.33 tsp	4.75 tsp	1.66 fl oz	2.33 fl oz	3.25 fl oz
50		2.0 tsp	3.75 tsp	1.25 fl oz	2 fl oz	2.5 fl oz
60		1.66 tsp	3.25 tsp	6.33 tsp	1.66 fl oz	2.0 fl oz
70		1.33 tsp	2.75 tsp	5.5 tsp	1.33 fl oz	1.75 fl oz
80		1.25 tsp	2.33 tsp	4.75 tsp	7.25 tsp	9.5 tsp
90		1 tsp	2 tsp	4.25 tsp	6.33 tsp	8.5 tsp
100		1 tsp	2 tsp	3.75 tsp	5.75 tsp	7.66 tsp
120		0.75 tsp	1.5 tsp	3.0 tsp	4.75 tsp	6.0 tsp

Example: Assume that the calibration of your sprayer (Steps 1-5) yields an output of 30 GPA and your sprayer holds 3 gallons. Your herbicide label for the target weed species dictates a herbicide application rate of 1 pint/acre. Go to the chart and read across from 30 Gal/A to the 1 pint column – the amount of herbicide to add per gallon is 3 tsp in the chart. Since your sprayer holds 3 gallons of total solution, you would add 9 tsp of herbicide in addition to the water in each tank.

Liquid Conversions:

- tsp = teaspoons; TBS = tablespoons; fl oz = fluid ounces
 3 teaspoons = 1 tablespoon 8 fl ounces = 1 cup
 2 tablespoons = 1 fluid ounce 1 cup = 16 tablespoons



Simplicity Works Best In Rough Terrain

By Charles Henry
TechLine Editor

White River National Forest horseback sprayers focus on treatments of roads, trails, camp areas, and other seed sources to minimize transport of seed out to non-infested areas. They can treat 1/2 acre per horse load – equivalent to 400 small patches of weeds treated.

When Tom McClure transferred from the Bitterroot National Forest to the White River in Colorado, he thought his weed-fighting problems were behind him.

Instead of spotted knapweed and sulfur cinquefoil, he inherited yellow toadflax, houndstongue, and leafy spurge. These weeds were gaining a serious toehold in the Flat Tops Wilderness and also spreading on some of the White River's finest rangelands.

"We looked at all the possible ways to manage these weeds with toadflax being our primary target species, especially where it occurs in small isolated patches," McClure states. "But because toadflax is so deep-rooted, hand grubbing is not effective. Plus it is disruptive and opens the soil to invasion and it is more intrusive to dig than use other methods. All wilderness weed work in Region II and elsewhere has to have Regional office approval to insure wilderness values are maintained."

EA Passes Easily

McClure completed an environmental assessment (EA) for herbicide applications in the wilderness and other forest backcountry that passed the comment period positively. One reason was his judicious use of chemicals with horse-mounted, CO₂-powered sprayers.

"Battery-powered sprayers may be considered mechanized which would be in violation of wilderness policy. With the CO₂ unit, there is no mechanized operation, just pressure. We cannot even use backpack sprayers with hand pumps. There can be no moving parts, which is the case with the CO₂ units," McClure explains.



Tom McClure, Range Program Officer on the White River Forest, holds one of the CO₂ bottles that power their horseback sprayers.

Like all federal land managers, McClure operates with very limited staff and financial resources. Many employees today do not have farm backgrounds and are not comfortable around horses, nor do they know how to load a pack animal. Plus, he needed a lightweight unit since some employees would not be able to lift heavy packs of water. Building on the CO₂ units he first used in Montana, McClure secured funding from a Colorado State Weed Fund grant, the White River BLM, and Dow AgroSciences to build a simple, durable horseback sprayer that could be used in the wilderness and with a minimum amount of training.

After several prototypes, McClure and range technician, Hal Pearce, settled on an aluminum frame pannier lined with lightweight, corrugated, and waterproof plastic developed by Dale Vance in Rifle, CO. Each unit is comprised of one 5-pound CO₂

container and four 5-gallon stainless steel canisters (obtained from the soft-drink industry), and a pre-set pressure regulator (40 psi). Each unit contains a double canister pressure hose assembly, spray hose and handgun. Rubber straps for securing the cans in the panniers and a collapsible bucket for refilling the canisters complete the setup. All hose connections feature stainless steel ball lock disconnects and the canisters have large collar plastic disconnects with o-ring seals on the lids. The canisters also have rubberized bottoms and top handles for easy loading.

The units are plumbed to dispense from two cans at once so pressure and weight are equal on both sides of the animal at all times. Because workers may not be skilled riders, the units are designed with the sprayer working on the ground, leading the packhorse or mule. A manual accompanies each spray unit and contains a list of CO2 sources, as well as calibration charts and guidelines that are simple and easy to understand.

With the funding grants, McClure and Pearce built 40 of the units, which are sold for the cost of materials (\$450 ea.). On the White River forest, they had four of the units working last summer and plan to expand as funding becomes available. Targeting yellow toadflax, they apply Tordon* 22K herbicide and 2,4-D at rates of 2 qt./acre and 20 oz./acres respectively. They focus on treatments of roads, trails, camp areas, and other seed sources to minimize transport of seed out to non-infested areas. They can treat 1/2 acre per horse load. If that doesn't sound like a lot, it is equivalent to 400 small patches of weeds treated.

Simple and Efficient

Although the horseback sprayers are best suited for small patches, McClure is experimenting with one 25-acre infestation in a very isolated area to see if they can handle larger areas effectively over a three or four-year period.

"We have larger areas of open Thurber fescue and forb communities with small patches of yellow toadflax interspersed with aspen and fir. We employ intensive photo point monitoring on these areas after we spray so we can measure results," McClure says. "But I don't want to get too sophisticated with monitoring in the wilderness areas or isolated forest areas. We just need to know enough to get back to the spots. I would rather our resources go for more weed control than more expensive monitoring. A few intensive sites are all that are necessary to evaluate success."

"These pack spray systems are simple, nearly fool-proof mechanically, require a short training session, and provide a safe working environment for the sprayer.

We find them to be the answer for our needs in wilderness areas and other rugged terrain situations," McClure concludes, "Ranchers would also find them handy for awkward-to-reach places around the ranch such as ditches or steep slopes." 



After several prototypes, this aluminum frame pannier lined with lightweight, corrugated, and waterproof plastic proved best.



(Above) Each unit is comprised of one 5-pound CO2 container and four 5-gallon stainless steel canisters, and a pre-set pressure regulator (40 psi). Each unit contains a double canister pressure hose assembly, spray hose and handgun.

(Left) All hose connections feature stainless steel ball lock disconnects and the canisters have large collar plastic disconnects with o-ring seals on the lids.

Short on Horsemanship? Get a Llama

By Charles Henry
TechLine Editor

Faced with scattered weed infestations on extremely rugged terrain containing cliffs, trees, and huge rock outcroppings, Cindy Owsley's management choices are limited, but not impossible. Owsley manages 54,000 acres of open space for the Boulder County Parks & Open Space program from her base in Longmont, CO. This open space land is comprised of farmland, foothills montaine, and plains.

These acres are managed for passive recreation, preservation of wildland, ag preservation, and cultural history enhancement. But these acres also contain infestations of diffuse knapweed, dalmatian toadflax, Mediterranean sage, spotted knapweed, and Canada

"People loved the llama and we have a public in this area that is very suspicious of herbicides. The llama can carry an 80-100 pound load and works all day without complaint. If anything, we probably did not work him hard enough."

thistle. The open space is also home to migration corridors for deer and elk, prairie dogs, wild turkeys, raptor habitat, and the endangered Preble's jumping mouse. Not only is the terrain challenging, but Owsley was limited by employees who did not have experience with horses, did not like carrying backpacks, and who were seasonal so training had to be short, if possible, to maximize field time.

Her program is fully integrated employing biological releases, handpulling, mowing, and controlled burning where possible. But these methods did not fit the 3,000-acre Walker Ranch open space unit located on the western edge of the county. Diffuse knapweed patches were scattered over extremely rough terrain at 7,500 ft. Rocky cliffs and trees eliminated aerial spraying, and remoteness and ruggedness eliminated ATVs, handpulling, or mowing. Owsley's research showed that Transline* herbicide would provide the best control for diffuse knapweed, not harm trees, and would require



Alicia Doran (left) Weed & Pest Management Specialist for Jefferson County, Golden, CO and Cindy Owsley (right) Boulder County Parks & Open Space, Longmont, examine a map of rough terrain where llamas will be used for weed control.

the least chemical in the environment. But getting the product applied was the problem. She had backpacked with llamas with her young children and knew that they were gentle, low maintenance, and "soft" on the environment. Working with the owners of Buckhorn Llama Company, Masonville, CO, Owsley leased a neutered male for \$250 per month that included all pack tack and halters. One of her seasonal employees, Bill Blecher, agreed to become a llama wrangler.

Owsley purchased a simple CO₂ powered spray system for \$700 that mounted in canvas panniers on the llama. Each pannier contains an inexpensive hard-sided cooler for the CO₂ bottles, herbicide bottles (2 liter plastic soft drink bottles), and regulator. Each pannier holds eight bottles containing a 2% solution of Transline* in water. They never mixed on the trail and would shift the bottles during the day to keep the load balanced.

"We carried 50 feet of hose so the llama could be tied off if needed while we sprayed around him. The public loved the llama and we have a public in this area that is very suspicious of herbicides. The llama can carry an 80-100 pound load and works all day without complaint. If anything, we probably did not work him hard enough and he became a bit lazy toward the end

*Trademark of Dow AgroSciences, LLC

of the summer," she explains.

Owsley found no real drawbacks to the system. She is using the llama again this season and has shifted the sprayer to four ten-hour days so they can maximize time in the backcountry. Ideally, she wants to find someone who will camp overnight and not need to return to the trailhead for several days at a time.

"Transline works great in this situation," Owsley states. It is highly selective, effective on diffuse knapweed, and leaves no residual. We can work under trees and get to all the weeds the first time, which is important in rugged terrain. It can be expensive if you have to go back. But the real bonus is that we can spray the weeds, satisfy the public's concerns, and improve the ecological integrity of this landscape," she concludes. 📦



Using llamas to carry a herbicide spray system solved the challenge of working in extremely rough terrain (above) coupled with employees with limited horse experience.



Each pannier contains a hard-sided cooler for the CO2 bottles, herbicide bottles (2 liter plastic soft drink bottles), and regulator. Each pannier holds eight bottles containing a 2% solution of Transline* in water.



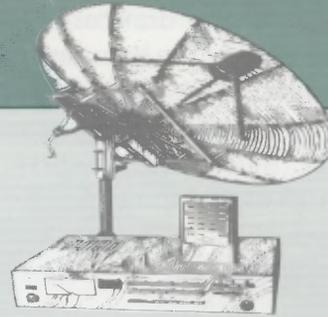
"Transline works great in this situation," says Cindy Owsley. "We can work under trees and get to all the weeds the first time, which is important in rugged terrain."

Llama Management Made Easy

Cindy Owsley says there are many advantages to using llamas, but her experience also shows there are some things that work better than others.

1. Select a neutered male, 7-years old or older.
2. Don't use a "pet" llama.
3. If you encounter a horse with a llama, move off the trail to the downhill side as quickly as possible to avoid spooking the horse.
4. There's not much llamas like, but they will tolerate most anything.
5. Llamas don't need grain, prefer rough forages, and don't need shoeing.
6. If possible, overnight llamas in a small pasture or corral to facilitate catching each day. A small catching pen within a larger pasture is also a possibility.
7. Work them steadily and consistently to keep them in condition and alert. They will carry 1/3 their body weight or approximately 80-100 pounds for a mature male.
8. Don't pet their heads or legs. Llamas establish herd pecking orders through head and leg biting.
9. Llamas don't spit as a general rule and are gentle.
10. A good llama can cost \$3,500, but many breeders will lease them per month.
11. Llamas should be hauled with a stock rack for safety.
12. Llamas have very low water requirements, which makes them ideal for backcountry work.

Will There Be 21st-Century Einsteins?



By Allan Felsot

The Seattle Times, January 7, 2000 (Reprinted with Permission)

Allan Felsot is professor of entomology and environmental toxicology at Washington State University, Tri-Cities Campus, Pasco, WA

As a scientist, I want to say hurrah over *Time* magazine's selection of Albert Einstein as the "Person of the Century," but instead I find myself melancholy over the state of science in our country and in the rest of the world.

In a stimulating and well-reasoned essay, *Time* declared that Einstein was the best person to represent the 20th century because the century will be most remembered not for its important social and political changes, but for its earthshaking technological advancements. The century began with horses pulling wagons and ends with the Space Shuttle exploring the heavens that Einstein helped explain.

Heart transplants, wonder drugs, and the development of electricity, radio, television, air conditioning, and computer technology - the 20th century accomplished things that were unimaginable to people of the 19th century. Einstein was the superstar of 20th-century scientists. His discoveries enabled many technologies to advance, and his choice to represent the century of science is inspired.

After such a century, we should be looking forward to the 21st century with

great optimism and great confidence in science and the wonderful technologies it has spawned. But instead we are seeing an unprecedented mistrust of technology.

Throughout history, people have failed to share in the vision of scientific thinkers. Galileo, for example, was imprisoned for saying the Earth was not the center of the universe. People said pasteurization would make food poisonous. But has there ever been such organized and widespread opposition as we see today?

A great deal of the opposition is directed at advancements in food production. Norman Borlaug, Nobel laureate and architect of the Green Revolution, which galvanized amazing growth in global food production, has written: "Science and technology are under growing attack in the affluent nations where misinformed environmentalists claim that the consumer is being poisoned out of existence by the current high-yielding systems of agricultural production. While I contend

this isn't so, I ask myself how it is that so many people believe the contrary? There seems to be a growing fear of science as the pace of technological change increases."

It is not so much the growth of fear as it is the growth of fear mongering. Environmental advocacy groups, which have grown exponentially in the past two decades, see the advances in agriculture as harmful to the environment. Borlaug and others point out that increased production has saved the environment. In 1958, before the Green Revolution, the average corn harvest was 53 bushels per acre; today, it averages about 135 bushels, with some farmers producing more than 300 bushels per acre. Similar stories are true for cotton, soybeans, wheat and other crops.

How does yield save the environment? It keeps land out of production and thus available for wildlife. According to Borlaug, if yields of 40 years ago prevailed today, three times more land in China and the United States and two times more land in India would be needed to meet cereal demand.

Global population is expected to increase by at least 50 percent in the next half century. Can agriculture meet the demand again? Not with current technology on current acres. Biotechnology is one of the ways to increase yields and add valuable traits to crops. Scientists have learned how to insert a single gene into a plant so it can protect itself against insects or disease. It will soon be possible to have drought resistance in crops, so people in sub-Saharan Africa, for example, can grow food where it wouldn't grow before. Scientists

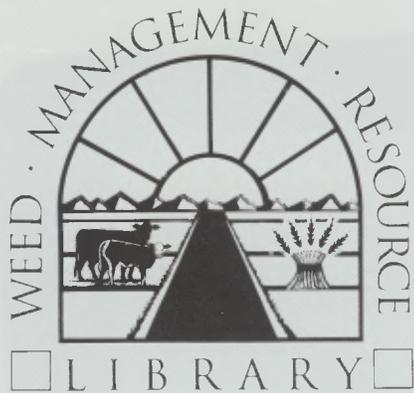
are working on rice that can yield 25 percent more grain.

Biotechnology also offers promise of foods that are enhanced with vitamins to ward off malnutrition, disease and childhood blindness. These advancements are not all being proposed by major corporations, which activists like to demonize. Many governments and private research institutions, both local and international, are involved in developing the technology.

But these tremendous benefits are being held up as anti-technology groups fan public fears. Ironically, the fear seems to be over the essentially old technology of plant breeding sped up a thousand fold using techniques of modern molecular biology.

The *Time* magazine essay stated that the discovery of DNA, the fundamental building block of life, was the 20th century discovery that would be most important to the 21st century. Just as Einstein unlocked the mysteries of molecules and atoms, the discovery of DNA is explaining how genetic traits can be mapped and developed for public good.

All of this progress is fully open and accessible to the public, and its ramifications are widely discussed in the corridors of our public institutions. Whether the promises of our 20th century discoveries blossom fully in the 21st century depends greatly on whether we trust scientists or alarmists as the new century begins.



Weed Management Resource Library 1-800-554-WEED (9333)

The *Weed Management Resource Library* (WMRL) contains a wide variety of information resources to improve your noxious and invasive plant management. The Library provides you with quick, convenient access to as many resources as possible in one location.

Through the *Weed Management Resource Library*, you may obtain complete copies or additional information on every subject that appears in *TechLine*. All aspects of noxious weed and invasive plant management are presented.

We want to answer your technical questions, so *TechLine* solicits your input and feedback. If you have a successful weed technique or program you would like to share with your colleagues— we welcome them. Please call us toll-free at the *Weed Management Resource Library* at 1-800-554-WEED (9333) with your

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suggestions, comments, and input.

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