IN-SITU DECONTAMINATION OF METAL-POLLUTED SOILS BY METAL-ACCUMULATOR PLANTS

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Published Papers:


Conference Papers, Abstracts, etc.:


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Cabbages provide a green solution to cleaning metals out of soil

WHENS THAT THRIVE on derelict land could soon be used to clean up contaminated sites. Research has shown that some of these plants absorb 100-300 times higher levels of metals than other vegetation - a property that scientists are trying to harness as a method of purifying soils naturally.

"Despite a number of innovative clean-up techniques coming on the market, none are satisfactory for cleaning up metal contaminants," says Dr Steve McGrath of the Institute of Arable Crops Research at Rothamsted in Hertsfordshire, one of three R&D establishments funded by the Agricultural and Food Research Council. Acid washing, for example, is one way of abstracting some metals but the process acidifies and damages the soil.

Scientists say that derelict land could be sown with the seed of chosen weeds or hyperaccumulators - which would absorb the metals as they grow. The plants draw the metal up through their roots to their leaves and can be cropped and dried before being disposed of.

"Ultimately the metals will be abstracted and recycled," says McGrath who predicts that it will be about five years before the process is in use.

Along with Dr Alan Baker of the University of Sheffield, McGrath is studying six species from the cabbage or Brassica family that absorb high levels of zinc, cadmium, nickel and lead. Field trials have shown that some of these strangely yellow and white-flowering plants will assimilate zinc, for example, at levels of 33,000 parts per million. That is a 1000-fold increase compared with other plants, says McGrath.

One drawback of plant purifiers is that the process can be slow. McGrath says that one experiment to clean up sewage sludge needed nine crops. "It would be possible to get two crops a year if you grew one of them under plastic greenhouses," he explains. Selecting and breeding the most efficient plant lines could speed up the process.

The Rothamsted team is working with Dr Scott Cunningham of Du Pont Chemicals in Newark, Delaware, one of the main centres of research in this area. Cunningham sees plants as a viable remedial action where pollutants are near the surface; are relatively non-toxic; pose little risk to health or the environment, and cover large areas. Like McGrath, he says that hyperaccumulators could be in widespread use in five years' time.

Cunningham points out that at some US sites, plants are already used for stabilising contaminants in the soil. Trials are also under way to use different species for cleaning up organic contaminants - such as herbicide spills. The US Army is experimenting with Bermuda grass for cleaning up oily sludges and the Department of Energy is trying to use pine trees for cleaning spills of trichloroethylene on the nuclear weapons manufacturing site in Savannah River, Georgia.

Cunningham's research group is concentrating on ragweed, another hyperaccumulator which could prove especially effective because of its size - species grow up to 3 m high. Ragweed is particularly effective in absorbing lead - ubiquitous because of car exhaust. The group is also beginning to genetically engineer species to increase metal uptake. But before manipulating the genes, the team has to pinpoint those responsible.

"We are on the right track," says Cunningham of his research. "Plants are already being used for cleaning up indoor air contamination and waste water streams. It's a logical step to use them to clean up soil."
Planten reinigen
verontreinigde grond

JAN WARWEEK

LIJNDE - Onderzoekers van het Britse onderzoeksinstituut Rotham-
stead Experimental Station (naal Londen), zijn erin geslaagd zware meta-
len uit de grond te verwij-
deren door middel van een specifieke
plantensoort.

Het Rothamstead-team vertaalde tijdens expedi-
ties naar Duitsland, België, Griekenland en Portugal ta-
den van planten die gediend op grond waarvan nature
en een hoges matie van zware
metaal aanwezig is.

Naast geschikt om grond te zuiveren bleken krui-
bloeimiige plantensoorten
van de Brassica familie (waarvan de koolsoorten
behoren). Het gaat om drie
soorten: Alysium (balsamicum
tenn), een aantal
soorten van Thlaspi, en een
plant genaamd Cardiam
nepals halier.

Weedspruit

De onderzoekers zaaiden
planten op een perceel in East-Engeland, waarop in
het verslagen veel rijnzal-
was uitgevoerd. In het
kweekplaats experiment
wordt een hoge mate ab-
surgie van zware metaal
besproken. Per hectare namen
de planten weegili kilo zink,
1500 gram nikkel, en 150
gram cadmium op.

"Dat is tienmaal meer dan de normale is voorgrond,
wordt door normale landbouwwe-
zen", zegt 

van het
onderzoeksteam
Dr Steve
McGrath. "Dat is
zeer
interpretaties
worden op
hoge
metalen.

Gevaarlijk

Volgens
McGrath zijn
stink-, en nikkel de
gevaarlijkste
metalen in de
landbouw.

"Het alleen zijn

die metalen schadelijk
voor het bedieningsstel-

heb, maar ook voor mens
dier. Vroeg ophelderen
is ge-
vaarlijk. Daarom moet

in de consumptie be-
ten terecht komen."

Uit eerder onderzoek is gebleken dat ook lage concen-
traties metalen uit al-
al een negatief effect op het
bodemlevens hebben. De

rhizobium-binding bacteria
Rhizobium leguminosarum
biertr ledit bijt extreem
gevuld te zijn. Deze bac-
ter leeft in de wortelknol-
beies van klever en dik

stikstof uit de lucht.

Uit de eerdere experimen-
ten konden de onderzoekers
niet met zekerheid conclu-
deren welk metaal nu pre-
cies verantwoordelijk is
voor de dood van de bodem-
organismen.

Lookverdeler

McGrath heeft nog geen
belanghebbend met ver-
hoogde opname van koper,
lood en chroom. "Daar
kok-
ken we nog plantensoorten
voor", zegt hij. "We maken
het hard ter hoogte van een
lookverdeler.

Het Rothamstead-onderr
zoek is het, even in de wo-
den en direct de praktijk
voor de praktijk. Persoon-
lijke die hervig zijn aangepike
door zware metalen, hebben

effectief 'schermbestend
kunnen worden. De gecons-
certeerde planten (die als
metaal behoud
en wettigh-
dagen voor gecontroleerde on-
staan worden verbrand wor-
den.

Dit zou een veel grotere
erschans voor grondverdi-
ing zijn dan afgeven.

"Het is de snelle prakti-
sche manier om zware ma-
talen uit de bodem te ver-
breiden", zegt McGrath.

Het onderzoek heeft zich
terug te zijn op een breed
verslag van verschillende
plantsoorten voor

doelgroepen. Onafhankelijk
die zeer succesvol was
gezien de stikstof

houders, en in de-

zaak.

Zaadontgeldingen

McGrath verwacht dat,
waarvan het onderzoek ver-
derd is gegeven, vooral
werkzaam is worden met

zaadontgeldingen. "De

ontkoppeling op de markt
hebben gegeven, "De

in de grond te

ontkoppelen, een vervelend
persoon kan binnen een tot
vijf jaar redelijk succes-

makkelijk worden, dat hebben
we reeds experimenteel be-
woenen", aldus McGrath.

"Ons onderzoek is van in-
ternationale belang, we
werken samen met Shef-
field Universiteit, en Mas-
sey Universiteit in Nieu-
w Zeeland."

Het huidige on-
derzoek wordt door de EG

financierd.
TV Interviews (AJM Paker)

May 1992
Calendar News, Yorkshire Television
[Gang Mines, Derbys; Labs. University]

25 June 1993
Newsround, BBC TV
[Gang Mines, Derbys]

Films
15 July 1993
Film Unit, Central Office of Information
[Gang Mines, Derbys; Labs. University]

Radio Interviews/Programmes
18 May 1993
Radio Sheffield, live

19 May 1993
LBC Newstalk, 18.45, live

19 May 1993
LBC 20.45, live

4 & 6 June 1993
BBC Radio 4, Natural History Programme

7 June 1993
BBC Radio 4, 'You and Yours'

In the pipeline:
1993
BBC TV, 'Tomorrow's World'

1993/94
Transatlantic Films. Filming over next two years for 'Plant Hunters' series on Discovery Channel
Remediation technologies
Various strategies exist worldwide, although in the UK remediation technology is a very young industry. Barry Ellis of Celtic Technologies has outlined some basic approaches:

- containment — synthetic liners, modified clay liners, jet grouting, slurry walls, ground freezing
- reduction of contaminant mobility — stabilisation and solidification
- contaminant removal — vacuum extraction, air stripping
- biological destruction — land spreading, composting and treatment bed destruction
- physical removal in situ — soil flushing
- physical removal ex situ — soil washing
- physical removal on-site — pump and treat
- high temperature oxidisation — thermal processing

It has to be remembered that remediation technologies are developing all the time and as the market grows the cost of remediation could fall. Rothamsted Experimental Station (part of the Agricultural and Food Research Council) is developing a low-tech solution based on plants absorbing heavy metals within one metre of the topsoil. Scientists have had success with plants from the cabbage family

Plants of Alyssum, Thlaspi and Cardaminopsis growing in a plot of a metal contaminated field at Woburn in Bedfordshire. These are field tests of the efficiency of these hyper-accumulator plants at removing heavy metals in the above-ground material, which can then be cut, taken away and recycled

Picture courtesy of Rothamsted
And not only will the plants grow in such soils, they absorb the metals from the soil into their stems and leaves. Then the plants can be harvested and heavy metals - , which are extremely valuable in industry, although they are toxic in the environment - can be recycled back into industrial uses.

Team leader Dr Steve McGrath says he believes that the plants he's developed - which are known as hyper-accumulators because they can absorb hundreds of times more metal than normal - are going to provide a safe, natural and cost-effective way of cleaning up contaminated soils.

PRESENTER:
The world's first experiment to see if plants could decontaminate polluted land is now under way in Britain. A team at the Rothamstead Agricultural Research Station at Harpendon near London have succeeded in developing plants which will grow in soil heavily contaminated with toxic heavy metals.
Decontaminating soil by plants

The world's first field experiment to test the potential of special plants to decontaminate polluted land is now under way in the U.K.

A team of scientists at the U.K. Agricultural and Food Research Council's (AFRC) Rothamsted Experimental Station at Harpenden, near London, has succeeded in developing plants that can grow in soil highly contaminated with heavy metals. Their experiments indicate that the plants can absorb the heavy metals from the soil, eventually leading to decontamination. It is likely that this research will lead to a safe, natural and cost-effective method for dealing with the problem of soil contamination.

Heavy metals such as zinc, cadmium and copper, which are present in sewage sludge, can have disastrous effects on the soil microbial population in treated farmland.

Over the past few years it has been found that even small concentrations of metals from sewage sludge applied to agricultural land can seriously interfere with soil microbiological activity. *Rhizobium leguminosarum* *brow vun trifolii*, the nitrogen-fixing bacterium that infects clover roots, is particularly sensitive.

In experimental plots of land contaminated with metal, only one strain of soil bug was tolerant to metals but unable to fix nitrogen with the normal host. Scientists involved in these experiments found it impossible to establish which of several different metals was responsible for the death of effective strains of microbe.

In the latest experiments, increasing concentrations of zinc, cadmium, copper and nickel were added separately to soil from the uncontaminated control plot of the experiment. The results showed that adding zinc at 1.3 times the U.K. limit for this element in sludge-treated soil, or cadmium at 2.4 times the limit, caused complete death of effective strains of microbe within 18 months. Copper at 1.7 times the limit decreased the number of deaths but did not cause complete elimination, and nickel had no effect.

Most plants at best can only remove small quantities of toxic metals from soil. But the present work has given new hope because the team has found that some specialised plants, known as hyper-accumulators, can absorb much larger concentrations of metals.

It has been shown that hyper-accumulators can absorb 10,000 mg zinc for every one-tenth of a kilogramme of dry matter, compared to about 30 mg in normal plants. In the case of cadmium, they can absorb 100 mg per one-tenth of a kilogramme of soil compared with the usual one milligramme. — LPS
University study finds plants absorb heavy metals

Wild cabbages ‘cure for polluted land’

Richard Suddes
Environment Correspondent

Researchers at Sheffield University are pioneering a simple and brilliant technique for cleaning up contaminated land - by covering the ground with wild cabbage plants.

A research team headed by Dr Alan Baber, a senior lecturer in the university’s Department of Natural and Applied Sciences, has just completed a two-year trial testing the capacity of selected wild plants to absorb pollutants from heavy metals such as zinc, cadmium, nickel and chromium.

The project, carried out under the auspices of the Agriculture and Food Research Council’s North-West Regional Research Station at Harpenden, Herts, has shown that plants can be more effective in stripping contaminants from exposed soil than expensive and environmentally-destructive methods now being used.

As an added bonus the metals absorbed by the plants can be recycled.

Thousands of acres of industrial and commercial sites around Britain - as well as some rural areas - are polluted by heavy metals from industrial and municipal waste dumping, metal working and contaminated sewage sludge used as a fertilizer.

Publicity over Government plans to scale back aid for post-competition has drawn a glint on many farming

industrial areas, including the Tees and Wear Valley in South Yorkshire.

The only attempt to clean up sites contaminated by heavy metals has been in the United States, using machinery where the soil is stripped in straw or unscarred with glass particles.

Both these techniques are expensive and take years behind a sterile soil which takes at least a decade to recover.

The Sheffield team has just completed its first project, funded jointly by the EC and the UK’s Agricultural Research Council, to test the feasibility of the new technique on a field trial.

The project, which is part of a wider EU-funded research programme in Britain, Belgium and Germany, has been a success.

Dr Baber said: “I have been working for many years on the evolution of resistance in materials in plants and a number of plants have shown unusual behaviour where as part of their life cycle in certain toxic materials, they actually store them.

“These experiments have shown that quite a range of plants absorb these materials in their tissues and shoots and we have realised there may be a way of using these to clean up contaminated soil biologi
cally rather than chemically.

“We have five years’ worth of experiments to date, with a number of studies in other countries showing that this technology can be implemented on a practical scale.”
Metal detecting' wild cabbages set to clean up poisoned land

Martin Weinwright

Wild cabbages may soon be deployed to mop up Britain's abandoned industrial sites, after the success of an investigation into their powers of absorbing toxic sludge.

Scientists from Sheffield University and the Government's Rothamsted experimental laboratories have found the plants can be more effective at neutralising metallic poisons than current detoxifying techniques.

The successful trials are likely to see the pale yellow blooms of wild cabbage join purple buddleia and pink willow herb as a part of the inner city landscape.

There are also hopes that 'cabbage-cleaning' could speed the renaissance of abandoned sites, in areas from London to South Yorkshire, where developers have been deterred by problems with cadmium, zinc or nickel traces.

The cabbage trials, funded by the European Community and Du Pont, the US chemical firm, have used a range of relatively uncommon species from Britain, Belgium and Greece. Dr Alan Baker, a senior lecturer in Sheffield's animal and plant sciences department, said the two-year experiment had proved a theory developed over 30 years' study.

Wild cabbages, which include brassicas like the favourite rockery plant lyssum, have developed an ability to adapt to poisons in the soil by absorbing them harmlessly into shoots and tissues. Their appetite appears to extend beyond metals to municipal rubbish and contaminated sewage sludge.

Dr Baker said yesterday: "A very small number of species go further and actively seek out toxins to take up, possibly as a defence mechanism against predators."

These vegetable metal-detectors will be at the centre of the project's next stage.

The research team is now hoping to breed the most voracious strains in large numbers, to tackle sites currently abandoned or treated slowly and expensively by acid-dousing or saturation with glass particles.
Pollution eaters

Sheffield scientist in research on how plants could clean contaminated sites

PLANT power could soon be cleaning up derelict land, thanks to research involving Sheffield University scientist Alan Baker.

Dr Baker, an expert on how metals in the soil affect plants, has been using his knowledge as part of a pollution-busting European Community-funded research project.

Now American chemicals giants Du Pont are showing interest in backing further research aimed at increasing the speed at which the plants absorb metals like zinc, lead, cadmium, nickel, copper and cobalt from the soil. Tests involving a range of wild and sometimes rare plants which thrive on soils with high metal concentrations show that they could be used to clean up plots of land over a period of years.

By Robert Rae
Industrial Editor

The plants concentrate the metals in their shoots, which are harvested and burnt. The ash — which can contain between ten and 20 per cent metal — is either recycled or disposed of as a hazardous waste.

Star Says: P6

Dr Baker has been working with Dr Steve McGrath, of the Institute of Arable Crops Research, who reckons it could be up to five years before plant power is being used to provide a green solution to pollution problems.

Even then, stresses Dr Baker, plants will not be a commercially viable solution when it comes to cleaning up heavily polluted sites or soils where the pollution is well below the surface soil.

This is not a technique that is viable for rapid clean-ups but it is an option for marginal land which is slightly contaminated and not wanted immediately for redevelopment," says Dr Baker, whose work is featured in the latest edition of the magazine Building.

Many of the plants being used come from Europe, but some are from Africa, where they are found at high altitude on land with naturally occurring metal deposits.

Some of the European species are rare that they are officially protected, but, if Dr Baker's research pays off, they could be a lot less rare in the future.

Plants being used include straggly yellow and white-flowering plants from the cabbage family that absorb zinc and ragweed, which is particularly good at absorbing lead.

Bakery boost
Weeds provide green solution to cleaning soil

By Denise Chevin

One drawback of plant purifiers is that the process can be slow, McGrath says that one experiment to clean up sewage sludge needed nine crops. "It would be possible to get two crops a year if you grew one of these under plastic greenhouses," he said. Selecting and breeding the most efficient plant lines could speed up the process.

The researcher team is working with Dr. Scott Cunningham at the Savannah River Site (SRS) which uses high metal accumulators which could prove especially effective because of its size - species grow up to three meters high. Breeding is particular effective in absorbing lead.

Cunningham's research group is concentrating on research which could prove especially effective because of its size - species grow up to three meters high. Breeding is particular effective in absorbing lead.
Tasty toxins tempt green gourmets...

Plants will be genetically engineered to clean up the toxic compounds that contaminate large areas of soil in industrial countries.

This is the aim of research projects being carried out and supported by DuPont.

Metal-eating plants derived from rare wild relatives of common or garden plants, such as cabbage, cress, turnip and ragweed, will remove pollutants from and restore them to productive use.

In DuPont's central research and development division at Glasgow, New York, USA, Dr Scott Cunningham and his colleagues are two years into a programme looking particularly at lead-contaminated soils.

At Sheffield University's animal and plant sciences department in England, Dr Alan Baker has pioneered the use of plants which have evolved a natural resistance to metals in order to develop a technology that is funded by the European Union.

Dr Baker has been studying metal resistance in plants for more than 20 years.

'Some plants actively bio-accumulate metals and do so internally,' he said.

'A considerable percentage of the plant's weight can be made of metal. Some of the zinc-accumulating plants are virtually galvanised.'

The brassica family, which includes the wild cabbage, radish, plantains' pure, cress, oil seed rape and turnip, are particularly adept at metal accumulation. It is not the familiar strains which are creating interest, however, but relatively rare adaptations only found in areas where metals occur naturally in the earth.

Dr Baker has travelled the world in pursuit of these plants known as 'hyperaccumulators'. He found a tree in New Guinea, for example, which had accumulated so much nickel - up to $6 per cent of the plant's latex - that the bark is cut it bleeds blue sap.

Dr Baker built up a seed bank of green metal detectors and tested them on an ideal site at Woburn in the UK, an unwanted site which has been added to DuPont's waste and mixed with wood chips to form compost.

We are looking towards the idea of genetically engineering a model plant which will be able to deal with more than one metal,' added Dr Baker.

'Such a plant could have the potential to clean up a site within six to eight years.'

Dr Cunningham's work for DuPont concentrates on lead because the company is committed to cleaning up sites contaminated many years ago when they produced lead-based products and explosives. Scott has been investigating many old former DuPont sites, as well as land where lead lined buildings had been burnt and even old smelter sites dating from the American Revolutionary and Civil Wars.

"Of the plants we have analysed to date, two have shown significant abilities to accumulate lead: hemp dogbane and common ragweed,' he said.

'Their lead accumulation abilities are not consistent in every soil. Most metals - and lead in particular - have numerous forms, not all of which are equally available for plant uptake.

'Our ultimate aim is to clone genes into the plants.'

The stakes are high: in the US alone the estimated cost of cleaning up hazardous waste is $70 billion over the next 30 years. Other parts of the world have similar problems and there is even hope of developing plants which could clean up the radioactive debris of the Chernobyl nuclear disaster.

It has even been suggested that bio-mining could be a potential substitute for conventional mining completely by planting metal-bearing crops, harvesting them, and smelting them to recover the metal.

'The potential uses of plants which absorb toxins are numerous,' says Scott, who is about to start work with Conoco in Fomca City to look at plants which might clean up oily sludge. A species of Bermuda grass is already known to grow on and help clean up oily sludge.

It is early days yet but hopes are high that current research will eventually allow scientists to find in the clones and make the solution to the major problem of contaminated industrial land a truly green one.

... while busy bacteria help clean-up our act

DuPont team has developed technology that uses natural soil bacteria to clean up groundwater and soil contaminated with chlorinated hydrocarbons, solving a major environmental and public health challenge.

Chlorinated solvents, also known as chlorinated hydrocarbons, are one of the most toxic pollutants in groundwater worldwide.

They are often by-products of manufacturing operations and are used in dry-cleaning fluids, metal finishing and electronic circuit fluids.

For the first time, bioremediation has removed contaminants from soil contaminated with chlorinated hydrocarbons, which are extremely hard to break down.

The team, which includes Conoco and DuPont representatives, demonstrated the technology at DuPont's Victoria, Texas site and is now testing the method to determine how broadly this technology can be applied.

In another development, a fourth 'R' has been added to DuPont's waste reduction arsenal.

Reduce, Reuse and Recycle have been joined by 'Rot', with bacteria and other micro-organisms being enlisted to help make sure that an important new DuPont plant meets environmental targets.

DuPont's first large scale waste composting operation, the natural process of plant decay will not only help to treat wastes at the adipic acid plant in Singapore, but create a product beneficial to the environment.

When the plant starts up in 1994, organic wastes from the manufacturing process will be fed to bacteria and other micro-organisms.

As these organisms feed, grow and multiply, they'll be periodically removed and mixed with wood chips to form compost.

We'll spread up the natural composting process by providing optimal growing conditions, namely air and water at the right temperatures,' explained Deb Laper of Engineering's Water and Waste Management Group.

Initially, the plan was to burn the excess microbes from the waste water treatment process. It is estimated that composting will cost several million dollars less than incineration while creating a beneficial product.

Once the safety of this is verified by DuPont, the technology will be shared with other industries and government agencies, it will be used to decrease erosion and promote lush vegetation at the site and marketed in neighbouring countries. I
Wild relatives of the cabbage could soon be used to help clean up Britain's contaminated industrial sites, following the success of a two-year trial conducted by a research team headed by Dr Alan Baker in the Department of Animal and Plant Sciences.

The project, carried out in collaboration with Dr Steve McGrath (a former BSc and PhD graduate of this University) at the Agriculture and Food Research Council's Rothamsted Experimental Station in Hertfordshire, has demonstrated that certain plants can be effective in removing potentially toxic heavy metals such as zinc, cadmium, lead and nickel from polluted land.

The 'green remediation' process they are developing could ultimately prove a less costly alternative to physico-chemical clean-up techniques currently employed in the USA and the Netherlands. It would also have the advantage of retaining the biological integrity of the soil rather than producing a sterile growth medium which generally results from present treatment options.

Funded by the EC and the American chemical firm DuPont, the plant trials have used a range of relatively uncommon metal-accumulating species from the UK, Belgium and Greece. These unusual plants, with a capacity to bioaccumulate several percent of metals in their shoots, have been identified by Dr Baker during research over the last twenty years. Whilst in the cabbage family, the nearest domesticated relatives of the plants being tested are the cresses and the common rockery plant, alyssum. All are native to soils naturally rich in heavy metals, often in areas of major mining operations.

Fundamental aspects of the mechanisms of metal accumulation by such plants are currently being investigated by Dr Baker and his research group. Some of the plants can scavenge metals from low soil concentrations, actively accumulating them in their shoots to similar concentrations as those found in plants growing naturally on the most metal-enriched soils. Dr Baker's group are investigating the possible role that the accumulated metals may play as a deterrent to herbivory and in control of pathogens.

Commenting on the project, Dr Baker said: "We have proof of concept - what we now need is a major development programme to breed and improve the most promising species and to generate sufficient materials so that this technology can be tested on a practical scale."

Another 'green technology' project underway in the Department of Animal and Plant Sciences involves the use of fast-growing, productive wetland plants - like the reedmace and common reed - to clean metal-polluted effluents from mining and mineral processing works.

Dr Baker and a research student, Mr Zhihong Ye, are collaborating with research groups at Baptist College, Hong Kong, and Zhongshan University, Guangzhou, PR China, in a project on the re-use of wetland plants in metal immobilization in both natural and constructed wetlands. The study, using materials from both Europe and China, aims to elucidate the mechanisms involved, and to allow selection of particularly useful strains of wetland plants for further development.
Weeding out the baddies

They may be a pest in the garden, but weeds may soon be used to clean up our dark industrial wastelands. Scientists in Britain are now trying to harness their power to revitalise land poisoned by high levels of metals.

At present, there is no satisfactory way of getting rid of the metals without damaging the soil. However, research has shown that some weeds absorb 100 to 200 times higher levels of metals than other vegetation.

And it is believed that they could be harnessed to ensure a natural way of cleaning up the soil for good — by absorbing the metals as they grow.

Harvested, they could then be cut up, dried and disposed of safely.

Dr Steve McGrath of the Institute of Arable Crop Research in Hertfordshire says that the ultimate aim is to remove the metals from the weeds and recycle them.

And he predicts that it will be only five years before the process is in use.

However, the actual clean-up could be a slow process: one experiment with sewage sludge needed nine crops of weed.

But says Dr. McGrath: "It would be possible to get two crops a year if you grew one of them under plastic greenhouses."

And selecting and breeding the most efficient plant lines could speed up the process.

Denise Chevin
Wild cabbage and contamination

Wild cabbages may be used to clean up abandoned industrial sites following an investigation into their ability to absorb toxic waste, according to a recent report in The Guardian.

Scientists from Sheffield University and the Government's Rothamsted experimental laboratories have found the cabbages can be even more effective at neutralising metallic poisons than current detoxifying techniques.

The trials have been funded by US chemical company Du Pont and the EC.
Earth Almanac

The Future Is Now for a Global-warming Test

How will plants adapt to the greenhouse effect—rising temperatures and carbon dioxide levels—the wages of fossil fuel burning and deforestation? To study the effects of such climate change, British scientists quite sensibly are using greenhouses—eight very sophisticated greenhouses (colored by creative photography) called Solardomes.

Built on the coast of Wales by the Institute of Terrestrial Ecology, the domes create conditions predicted for the late 21st century. Their air contains twice today's carbon dioxide and is 5.5°F warmer than outside air. Growing in the domes, grasses and small oaks and sycamores are measured by scientists, who also monitor caterpillars and aphids that feed on the vegetation. "Some plants may adapt by growing quicker and bigger. Others may slow down," says project leader Trevor Ashenden.

Contaminated Soil: Can Plants Get the Lead Out?

For 30 years an E. I. du Pont de Nemours & Co. plant in Deepwater, New Jersey, made tetraethyl lead, a gasoline additive that was phased out in the 1980s. High concentrations of lead now contaminate 25 acres. Yet in this wasteland, two weeds—common ragweed and hemp dogbane—not only grow but thrive, even as lead accumulates in their tissues. So company researchers (left, from left to right) Scott Cunningham, Steve Germani, and Bill Berti have planted more of the weeds to see if they and other plants can draw significant amounts of heavy metals from contaminated soils, a technique called plant remediation.

"All plants store some metals in their roots," says Scott, "but a few have likely gained an advantage by storing them in their leaves too. That way they may avoid being eaten by bugs or infected by a fungus." If the researchers can increase a weed's lead intake to one percent of its mass, the plants could be cut, dried, and burned to reclaim and recycle the lead.

Tiny Desert Fox Must Be Wily to Survive

Life presents a host of hazards for the cat-size San Joaquin kit fox. Of this endangered subspecies only about 5,000 remain. Their southern California neighbors include coyotes and golden eagles, which prey on them. A bullying outsider, the red fox, is invading their territory. Agriculture has gobbled up more than 90 percent of the kit foxes' former range, virtually restricting them to the Carrizo Plain, a 400-square-mile basin of grassland and scrub. And that shrunken habitat can be seared by drought.

But the foxes have friends. The Nature Conservancy has bought a 23,000-acre ranch, expanding the Carrizo Plain Natural Area to 200,000 acres, which the group manages in cooperation with the state and the U. S. Bureau of Land Management.

—John L. Eliot

National Geographic, August 1993
Flower power rocks heavy metal

Paul Lewis talks to two of the scientists who are harnessing nature's power to clean up polluted sites.

Some of Britain's ugliest and most polluted sites could soon be transformed into fields of brilliant yellow and white flowers as a result of a new, low-tech way of reclaiming contaminated land.

More importantly, the beneficent action would not just be visual. It would clean the soils of toxic heavy metals such as zinc, cadmium and nickel, and could be the first step in harnessing nature to fight back against pollution.

It is all down to the ability of certain remarkable plants, including cress and other members of the cabbage family, to flourish on polluted soils and absorb metallic toxins through their roots.

The metals were deposited by industrial effluent, sewage sludge and airborne pollution and have made thousands of acres across the country deplorable and unsuitable for agriculture.

Reclaiming the land used to cost huge sums and kill off any life it contained. The two farmers met acid leaching to dissolve out the metals at more than 1,000C to free them with the aid of the sun.

Successful trials of plant 'hyperaccumulators' at Sheffield University's department of animal and plant sciences showed the method was such a success that it could replace such extreme measures.

Scientists have been growing purple brassicas, the crops of a site near Woburn which was polluted by 20 per cent metal oxides from which it is easy to remove the metals.

Though this is unlikely to be commercially viable yet, it may well become so as reserves are depleted and genetic engineer ing increases plants ability to absorb the metals.

Another exciting prospect is that there may be 'hyperaccumulators' for other metals. A large range of flora has not even been charted, let alone investigated for potential exploitation.

McGrath has high hopes for this. "New hyperaccumulators are being found all the time. We already know of 343 for nickel alone. There are experiments to transfer the plants onto the crops of a site near Woburn which was polluted by 0.1 per cent metal oxides from which it is easy to remove the metals.

Though this is unlikely to be commercially viable yet, it may well become so as reserves are depleted and genetic engineer ing increases plants ability to absorb the metals.

Another exciting prospect is that there may be 'hyperaccumulators' for other metals. A large range of flora has not even been charted, let alone investigated for potential exploitation.

We know of a chromium accumulator growing in tropical regions, but this would obviously be unsuitable to the climate in this country. We're also investigating the lead-accumulating properties of another plant, though it's too early to be sure yet.

Baker believes it is possible that accumulators may be found for precious metals, a prospect which could make him a millionaire.

His work, it seems, brings the dream of harvesting fields of gold and silver one step closer to reality.

The Observer, 1st August 1993
Metallfressende Pflanzen entgiften Böden

„Hyperakkumulatoren“ nehmen große Mengen an Schwermetallen auf / Rückgewinnung

Scientists using flowers to suck toxics out of ground

By Paul Lewis
London Observer

LONDON—Some of Britain's ugliest and most polluted sites could soon be transformed into fields of brilliant yellow and white flowers as a result of a new, low-tech way of reclaiming contaminated land.

More important, the beautification would not just be visual; it would cleanse the soils of toxic heavy metals such as zinc, cadmium and nickel and could be the first step in harnessing nature to fight pollution.

The plan hinges on the ability of certain unremarkable plants, including members of the cress and cabbage families, to flourish on polluted soils and absorb metallic toxins through their roots.

Thousands of acres across Britain have become dangerous and unusable as a result of industrial effluent depositing, sewage sludge and airborne pollution. Reclaiming such land usually costs huge sums and kills any life on the land. The two favored methods were acid leaching to dissolve out the metals, and soaking at high temperatures to flush them with the acids in the soil.

But success with plant "hyperaccumulators" at Sheffield University may soon render such measures obsolete.

Scientists have been growing pennywort and similar cress for a site near Windscale, and the cress could well be the answer to those in the center of London who have been worth cleaning. All that is left to change.

Alan Baker, a scientist at the university, said the result could herald the beginning of a new type of "green revolution" that natural pollutants will be turned into useful by-products. The cress, Baker says, can be grown in sewage sludge and returned to agricultural and horticultural use. Together with other Institute of Arable Crops in the UK, the processes may be used to decontaminate more severely polluted sites.

"What we found was that an already rich black earth could become a target for other plants."

In other countries, hyper-accumulator species are under threat as rain forests are cleared. Baker believes there's an urgent need to collect the plants and cultivate them for their own protection. Once over that hurdle, large-scale use for soil cleansing can start.

The technology may have other applications. One could be as a way to recycle metals lost as industrial or other waste. When the cresses are harvested and incinerated, the ash contains up to 20 percent metal oxides from which it is easy to remove the metals.

Though this is unlikely to be commercially viable yet, it may well become so as reserves are depleted and genetic engineering increases plants' ability to absorb the metals.

McGrath has high hopes for finding more hyper-accumulators, noting that there are already 243 known nickel accumulators and a lead accumulator is being studied. And Baker believes it's possible that accumulators may be found for precious metals.
Pflanzen ziehen Zink und Blei aus verseuchten Böden


Erst einmal konventionell, durch Auslese und Zucht, will McGrath die metallfressenden Talente seiner „Hyperakkumulatoren“ verbessern. Sollten die Forscher sie mit Mitteln der Gentechnologie optimieren – womu sich in England ein Genehmigungsverfahren nötig ist –, dann müßte sichergestellt werden, daß sich die metallfressenden Pflanzen nicht unkontrolliert vermehren. Eine Samenmiscolung gegen Schwervermetalle müßte sich in ihrem Appetit auf metallische Böden beschränken.

Die Welt
British Association: new techniques offer hope for ecologists but problems for the health service

Rare plants swallow metals that poison the soil

RARE plants from remote Pacific islands and alpine regions could be used to transform heavily polluted land, British and New Zealand scientists have discovered.

Detectable techniques, ranging from chemical extraction of heavy metals from soils to immobilising affected areas by turning them to grass, all have drawbacks. These include cost and the need for special equipment and trained staff.

RARE plants are expected to flourish on soils polluted by heavy metals.

Professor Steve McCardle, of the Institute of Arable Crops Research at Rothamsted experimental station in Harpenden, Hertfordshire, said yesterday: "Decontamination of soils polluted with heavy metals remains one of the most intractable problems of clean-up technology."

Some techniques involve chemical extraction of heavy metals from soils to immobilise affected areas by turning them to grass, all have drawbacks. These include cost and the need for special equipment and trained staff.

The plants promise a low-cost solution which, if successful, will be able to return polluted land back to agricultural, recreational or building use.

Some of the plants identified could also be harnessed for economic use. One of the species, Solenostomus ascioides, from New Caledonia in the Pacific, produces a sap which is laden with nickel and chromium. It could be tapped for nickel for industrial use in the same way as latex is tapped from trees to produce rubber, Professor McGreal said.

He said that smelting and metals companies were showing interest in their research. When burned, the ash of the plants could contain as much as 20 per cent of heavy metals at the equivalent of a good ore.

The chemical company Dupont had also expressed an interest in the plant as a way of cleaning lead-contaminated soil at an American factory that once produced the pesticide agent ethyl lead. The research, carried out in co-operation with Massey University in New Zealand, was funded by the European Community, the Leverhulme Trust and the United States Agency.

Professor McGreal, speaking at the British Association's annual meeting, said that additional research was urgently needed to collect and conserve the rare plants used in the experiment. In some cases they were threatened by activities such as mining in their native habitats.

Cultivation programmes were also needed so that the promising plants could be brought into large-scale production for treating polluted land. More trials would need to identify those that would grow fastest in countries such as Britain.

Professor McGreal said genetic studies to discover the genes that control the uptake of heavy metals in the plants were also required. Once identified, these could be engineered into other, possibly faster-growing native species such as willow or grasses.

Research was also needed to decide on the best way of disposing of the plants once they had become saturated with the heavy metals. Given the high concentrations of heavy metals which they absorbed, it might be possible to extract and recycle them for industrial purposes, Professor McGreal suggested.

Dr Susan Gregson of the Applied Environmental Research Centre in Colchester, Essex, said the area of derelict land, including land contaminated by chemicals and heavy metals, could exceed 50,000 hectares in Britain.

Professor McGreal said there were vast areas of the country polluted with heavy metals. Many were near old mines or smelters. Most cities had a "halo of heavy metals" around them, a legacy of past industrial activity.

"Garden soils in old housing areas are quite contaminated."

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THE TIMES, LONDON

51 AUG 1983
Clean-up crops tested for work on toxic soils

Plants which take up toxic metals as nutrients could be used to clean contaminated soils. The crop would then be harvested and metal extracted for recycling.

Professor Steven McGrath of the Agricultural and Food Research Council’s Institute of Arable Crops Research described the experimental process – called green remediation – to the British Association meeting.

His research team has tested a number of plants for zinc uptake on soils polluted by heavy metals from London sewage over 20 years. The most efficient plant, alpine pennycress, reduced zinc to acceptable levels after nine croppings. Prof McGrath said this could be achieved in three years, using intensive cultivation.

Existing methods of physical and chemical treatment to remove soil pollution are expensive and also alter the soil structure, leaving it unsuitable for cultivation.

Using green remediation techniques, a hectare of contaminated soil could be cleaned up for £5,000, leaving it fertile, whereas conventional treatment by vitrification costs £18,000 per hectare.

At present the potential of the technique is limited by the productivity of the plants. Prof McGrath suggests that plants could be genetically engineered to speed up the rate of remediation and to improve the plants’ take-up of toxic metals to levels where the metals could be harvested economically.

Du Pont, the international chemical company, is interested in using the technique to clean up lead contamination around factories where the petrol additive tetra ethyl lead was produced, and a smelting company plans a test to produce pure metals from harvested material.

Plants which have the ability to handle toxic metals are scarce and need to be protected, Prof McGrath said.

One of the champion natural accumulators is Sebertia acuminate, a tree that lives on nickel-rich soils. “An obvious application would be to ‘tap’ such trees for nickel, in an analogous way to that for rubber.” Prof McGrath said green remediation could be combined with bioremediation, the technique in which bacteria are used to break down organic pollutants such as pesticides to produce a one-stage clean-up.

He said he would also like to study plants in areas where there is a high level of radioactivity, to see if they accumulated radioactive materials.
Cabbage 'king' in tackling poisons

Tom Redford

SCIENCE is on the verge of developing plants which can gulp up prodigious quantities of poisonous metals from contaminated land, then be recycled as though they were aluminium cans.

Metallic poisoning of soil — usually from mine workings, factory chimneys and effluent — has been a growing problem, particularly in eastern Europe. Even the urban vegetable patch is not immune, Professor Stephen McGrath told the association's meeting.

But a range of weeds and crops has been found which flourish on nickel, cobalt, zinc, cadmium and lead.

Professor McGrath, of the Rothamsted Experimental Station, said that within five years a plant could be grown especially for sowing on slag heaps and contaminated land.

"The ideal would be to harvest the plant material, dry it, and take it to smelters and recycle the metals in it, just as aluminium cans are recycled now." So far, out of 250,000 flowering plants, scientists have discovered nearly 100 which seem to have an appetite for toxic metals.

Professor McGrath and colleagues have been growing test plants on a field which has been contaminated by metals concentrated in London sewage sludge.

They made trials with plants they dubbed "hyperaccumulators."

One, a member of the cabbage family known as Thlaspi, or alpine penny-cress, emerged as the star. A crop removed 33 kilograms of zinc per hectare in a mere nine harvests.

"It would do a very good job on zinc, but what we would like to know is, can it do other metals?" he said.

The plant could be genetically engineered to take up a cocktail of metals. But at present Professor McGrath is using more old-fashioned selection techniques to seek a superplant within the Thlaspi family which would perform even better, especially if encouraged by manure.
Plants suck metal
from polluted land

PLANTS that "suck" valuable metals out of polluted soil could provide a lucrative crop for the future, scientists said yesterday.

Lead in land around Britain's abandoned smelting mines, or sprinkled for years on roadside verges, could be siphoned up, leaving clean, fertile soil.

Steven McGrath, from the Agricultural and Food Research Council's Institute for Arable Crops Research in Hertfordshire, told the meeting that such "hyper-accumulator" plants can store thousands of times more metal than "normal" species. The latest in one example, Serratia cascadensis, a native of metal-rich soils, can be 11 per cent nickel. It might be possible to tap these trees for nickel as others are tapped for rubber.

Scraping one metre of topsoil off a polluted site produces

Susan Watts
Science Correspondent

around 3,000 tons of metal-contaminated soil per hectare. This dries down to just a few kilograms of ash with metal concentrations of up to 20 per cent.

"We are told by people who do smelting that this is equivalent to a good ore," McGrath said. He said DuPont, the United States chemical giant, is interested in using his "bio-ore" techniques to clean up land contaminated with lead.

"Around Britain's cities, metal industries have produced horizons of lead polluted with metal deposits. The old mining sites where they smelted the lead emitted a lot of metal which came down on hills and meadows," McGrath said.

Dr McGrath's team tested 10 plant species on a site contaminated with 20 years' worth of London sludge and recorded the uptake of metals such as zinc, copper, manganese and cadmium. The researchers found that three species - a close relative of alfalfa, an alpine penny cress and northern rock cress - had an unusually large capacity for storing metals.

He is confident that the work, funded in part by the US Army, is a cheaper way to deal with polluted land than any of today's approaches.

"What are the insurance companies going to do [if you have a gene that means you aren't going to see your mortgage expectancy through]?"

Professor Evans said there was an urgent need for a debate on the ethical and social consequences of an increased lifespan.

"It is timely to think about it so that we don't get taken by surprise if scientific dreams become reality."
It's cleaner by cabbage

PLANTS from the cabbage family could clean land contaminated with toxic wastes, says Prof Stephen McGrath of the Rothamsted Experimental Station, Harpenden. The plants have proved promising at removing zinc, cadmium and nickel. Trials have been funded by the EC, Leverhulme Trust and the US army to decontaminate a field treated with metal-contaminated sludge. The method could take another five years to develop. R H
Plants could clean contaminated land

Land contaminated with heavy metals could be cleaned by plants which extract the contaminants and store them in their above ground portions, according to a paper presented at the British Association for the Advancement of Science conference in August.

Steven McGrath, from the AFRC Institute of Arable Crops Research at Harpenden, said a number of plants acted as 'hyper accumulators' with leaves containing high concentrations of metals such as cadmium, copper, lead, nickel and zinc.

Plants growing on a contaminated site could be cropped, and the metal-enriched biomass either disposed as landfill or reduced to ash, which could allow metals to be recovered and recycled.

Professor McGrath said the 'green remediation' of contaminated sites would leave soil in better condition than other clean-up techniques, such as acid-leaching, electro-osmosis, or vitrification, which remove all biological activity and affect the soil structure.

Species of plants which act as hyper accumulators vary from herbaceous plants to trees. The latex of one tree, Sideritis acuminata from New Caledonia, contains more than 11 per cent nickel, which could possibly be 'tapped', as other trees are for rubber.

An experiment was carried out on a field where metal-contaminated sludge from London had been applied for 20 years. Ten species were grown to test their ability to remove metals, one of which, Thlaspi caerulescens, reduced the amount of zinc in the soil to an acceptable level after just nine cropings. Alyssum tetanum would remove the same amount of zinc after 86 cropings, and oilseed rape, by contrast, would require 832 cropings.

Professor McGrath pointed out that hyper accumulator plants are relatively rare, and often grow in remote areas. Some of the plants are hard to crop, and new machinery may have to be developed to cope with low-growing or short-lived species.

'Ve look forward to seeing contaminated and abandoned sites 'growing clean' with a carpet of yellow and white flowers of hyper accumulator plants.'

More research needs to be done to identify other suitable species, and to find ways of increasing their efficiency as accumulators, he added.

Copies of Plants clean up soils can be obtained from Professor Steven McGrath, Soil Science Department, Rothamsted Experimental Station, Harpenden, Hertfordshire AL5 2JQ.

Botanists at Cambridge University are breeding a variety of elm which has greater resistance to Dutch elm disease than the ordinary elm, and which could be used to replant areas devoid of the tree for more than 20 years. About 200 saplings of the smooth-leaved elm are being planted around Cambridgeshire as a pilot study.
Plants may be able to save poisoned soils

SCIENTISTS believe that plants may solve the problem of decontaminating polluted soils following their discovery that a small but growing number are capable of accumulating very high concentrations of metals in their stems and leaves.

More than 70 species are now known to be what are classified as hyperaccumulators.

These contain hundred to thousands times larger metal concentrations in their above ground parts than normal, and range from herbaceous flowering plants to trees.

"The discovery of an increasing number of hyperaccumulator plants has opened up the prospect of seeing contaminated and abandoned sites 'growing green' with a cover of yellow and white flowers of hyperaccumulator plants," says Dr Steven McGraw from Britain's Institute of Arable Crops Research at Harpenden, near London.

At present there are no such techniques for such a clean up which are low cost and retain soil fertility after the metals contamination has been removed.

Hyperaccumulator plants include Seberia acuminate, which is native to nickel/chromium-rich soils in New Caledonia. The latter in this tree contains more than 1% nickel and is blue because of this.

"An obvious application would be to tap such trees for nickel in an analogous way to that for rubber," he says.

Backed financially by the European Community and the Leverhume Trust scientists in Britain and New Zealand have been carrying out field experiments on a site where metal-contaminated sludge from London had been spread for 20 years.

Ten species of plant were grown to test their efficiency for removing metals in above ground biomass.

"This method shows promise for cleaning a modestly polluted site, in situations where the remediation can be considered over a number of years. Mixtures of species might be grown in future rather than the monocultures used in our tests, in order to remove several metals simultaneously where there is the usual multiple contamination," continues McGraw.

Because hyperaccumulator plants are still relatively rare and found only in remote areas, there was an urgent need to collect and cultivate them, and to establish a germplasm facility for their large scale production.

Future work could involve genetic engineering to further improve metal uptake characteristics once the genes for metal accumulation had been identified.

The possibility then existed to transfer genes for metal hyperaccumulation into a productive but inedible host plant.
PLANTS CAN CLEAN UP CONTAMINATED SOILS

Scientists believe that plants may solve the problem of decontaminating polluted soils following their discovery that a small but growing number are capable of accumulating very high concentrations of metals in their stems and leaves, and more than 70 species are now known to be what are classified as hyperaccumulators.

At present there are no techniques for such a clean-up which is low cost and retains soil fertility after the metals contamination has been removed. Hyper-accumulator plants are still relatively rare, and found only in remote areas, as an urgent need to collect and establish a facility for their large-scale production.

For further information, please contact Stephen McGraph, AFRC Arable Crops, Rothamsted Experimental Station, Harpenden, Herts AL3 4AS; 044-582 763133; Fax: 044-582 763134.
Trees that can draw out the poison

Planting may prove to be the best way of cleaning up polluted land. Nuala Moran reports

Companies responsible for restoring polluted industrial sites may be able to cut clean-up costs by planting trees that absorb poisonous heavy metals. They could then gain commercially by harvesting the wood that shoots from the roots of the trees after they have been cut down.

This approach, known as green remediation, is suggested by scientists at Glasgow University, who are beginning the search for suitable trees by analysing this year's growth of alders, willows and poplars on a site that has been poisoned by decades of heavy industrial use.

The decontamination of soils polluted with heavy metals is one of the most difficult problems in cleaning up derelict land. Existing techniques of chemical and physical extraction or immobilisation in situ, are all expensive and require special equipment and operators. Vitrification, for example, costs about £18,000 for each hectare (2.5 acres). These methods also remove all biological activity from the soil and damage its physical structure.

With funding from Scottish Enterprise, Dr Ian Fulford and his colleagues in Glasgow will also grow trees in soils contaminated with controlled amounts of cadmium, chromium and zinc to measure absorption rates and calculate the time it would take to clean up a given volume of soil. The scientists need to establish where the metals are distributed in the tree. If they end up in the leaves, the scheme would be pointless, because the soil would be recontaminated each autumn.

The Government is currently offering farmers grants in an attempt to revive coppicing - the practice of cutting trees down to root level and then harvesting the wood that shoots from the base - as a fuel for power stations, and cash could also be earned in this way.

Planting and tending a woodland until it can be coppiced costs about £1,300 a hectare, but as the market is not yet established, it is unclear how much coppiced wood would be worth. Wood from contaminated sites could not be used for fuel, since this would spread the pollution.

Many industrial sites are in built-up areas and Dr Fulford says planting trees that can extract heavy metals will also have the advantage of providing cover to prevent the pollution spreading in water run-off or blowing around in dust.

Another research group, led by Dr Steven McGrath at the government's Arable Crops Research Station at Rothamsted, Hertfordshire, is studying the use of plants that grow in naturally metal-rich soils for remediation. Dr McGrath says some plants accumulate metals at such high levels that they could provide a source of those metals. Genetic engineering to improve the uptake of metal is also on the agenda.

If these methods of green remediation can be proven, Dr Fulford suggests that metal-accumulating plants and trees could be used in combination with bioremediation, in which micro-organisms are added to soil to break down organic pollutants, to clean up polluted sites completely.
Pflanzen zur Entgiftung kontaminierten Böden

(BN) Nachdem Wissenschaftler entdeckt haben, dass einige Pflanzenarten in der Lage sind, sehr hohe Konzentrationen von Metallen in ihren Stielen und Blättern zu speichern, haben sie die Ansicht geäußert, dass Pflanzen vielleicht zur Lösung des Problems kontaminierten Böden beitragen könnten.

Über 70 Arten sind bisher bekannt und werden als sogenannte „Hyperakkumulatoren“ bezeichnet. Die Pflanzen, unter denen krautige bis hin zu Bäumen vertreten sind, enthalten das 100- bis 1000fache der üblichen Metallkonzentration in ihren oberirdischen Sprossen.

Dr. Steven McGraph vom Institute of Arable Crops Research in Harpenden bei London sagte kürzlich auf einer Konferenz, dass die Entdeckung von immer mehr Hyperakkumulatoren die Perspektive eröffnet habe, kontaminierte Böden und Industriebanken mit einem Teppich weiß- und gelbbunterlegender Hyperakkumulator-Pflanzen zu reinigen. Gegenwärtig gibt es kein Reinigungsverfahren, das kostengünstig und die Bodenfertilität nach Beseitigung der Metallbelastung erhält.

Als ein Beispiel eines solchen Hyperakkumulators nannte Dr. McGraph die *Sebertia acuminata*, die auf Nickel- und chromreichen Böden in Neukaledonien heimisch ist. Der Latex dieses Baumes enthält über 11% Nickel und ist daher blau gefärbt. Laut Dr. McGraph wäre es nur logisch, solche Bäume analog zur Gummigewinnung zur Gewinnung von Nickel anzupfropfen.


Dr. McGraph sagte zu den Ergebnissen: „Diese Methode zeigt vielseitig ansprechende Ansätze zur Reinigung einer mässig belasteten Industriebrauerei, wenn man für die Reinigung einige Jahre Zeit hat. In Zukunft kann man vielleicht eine Mischung verschiedener Arten auspflanzen, statt der in unseren Versuchen gepflanzten Monokulturen, um dem Boden dort, wo es sich um die übliche Mehrfachverschmutzung handelt, mehrere Metalle gleichzeitig zu entziehen.“

Da Hyperakkumulatoren noch relativ selten und bisher nur in abgelegenen Gebieten gefunden wurden, sieht Dr. McGraph die Notwendigkeit, sie zunächst zu identifizieren und zu kultivieren und eine Kombinationseinspritzung für ihre Züchtung vorzusehen. In Zukunft könnten die Mitarbeiter des McGraph Institutes von Abfallstoffen mit Hilfe der Genetik zu optimieren, wenn die für die Metallentfernung zuständigen Gene identifiziert seien. Dann besteht die Möglichkeit, die entsprechenden Gene auf leistungsfähige, aber ungeniessbare Wirtspflanzen übertragen zu können.

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ARIA MEETING

Sewage sludge cleansed

Maintaining soil quality gave delegates at last week’s meeting of the Arable Research Institute Association plenty to talk about. Andrew Blake reports.

FARMERS on land polluted by heavy metals, perhaps from sewage sludge, could eventually be able to clean it up by growing special crops.

According to Professor Steve McGrath of Rothamsted Experimental Station, it might even be possible to recover valuable metals by processing the harvested plants.

He points out that the amount of sewage sludge destined to end up on farms after 1996, when it may no longer be dumped at sea legally, is likely to be considerable.

Control of industrial effluents has helped reduce the amount of heavy metals like zinc, cadmium, chromium and lead in sludges. But much comes from domestic sources.

Increased recycling of municipal wastes and the use of composts is likely to add to the burden.

Unlike nitrogen, such metals leach only very slowly, says Prof McGrath. Field tests in 1985 showed that more than 80% of the zinc, cadmium, copper, nickel, chromium and lead applied between 1942 and 1961 remains in the cultivated layer. “They are very persistent and stay in the topsoil.” Normal cropping might take 2000 years to remove them.

Long-term trials have proved they could harm nitrogen-fixing bacteria associated with white clover, he explains. The possibility that other soil micro-organisms could similarly be affected merits a cautious approach.

A recent government review on the use of sewage sludge recommended that the legal limits be tightened. The justification for setting different levels according to soil pH is also due for a rethink.

A more radical way forward is the use of so-called “hyper-accumulators”. These are plants which are unusually efficient at concentrating heavy metals in their tops.

In what Prof McGrath believes is the world’s first field experiment to test the idea, researchers at Woburn have discovered some species could absorb up to 30,000 parts per million of zinc but stay healthy. “A normal plant or healthy soil would have about 30ppm, and on polluted soil 300ppm.”
Kontaminierte Böden mit Pflanzen entgiften


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Als ein Beispiel eines solchen Hyperakkumulators nannte McGraph die Sebertia acuminata, die auf nickel- und chromreichen Böden in Neukaledonien heimisch ist. Der Latex dieses Baumes enthält über 11% Nickel und ist daher blutlich gefärbt. Laut McGraph wäre es nur logisch, solche Blume analog zur Gummigewinnung zur Gewinnung von Nickel anzupflanzen.


Der Wissenschaftler zu den Ergebnissen: „Diese Methode zeigt vielversprechende Ansätze zur Reinigung einer mäßig belasteten Industriebahne, wenn man für die Reinigung einige Jahre Zeit hat. In Zukunft kann man vielleicht eine Mischung verschiedener Arten aufpflanzen statt der in unseren Versuchen gepflanzten Monokulturen, um dem Boden dort, wo es sich um die übliche Mehrfachverwendung des Geländes handelt, mehrere Metalle gleichzeitig zu entziehen.“

Da Hyperakkumulatoren noch relativ selten und bisher nur in abgelegenen Gebieten gefunden wurden, sind die englischen Wissenschaftler der Notwendigkeit, sie zunächst zu identifizieren und zu kultivieren, um eine Keimplasma-Einrichtung für ihre Zucht zu gründen, in der Zukunft könne man versuchen, die metallspeichernden Eigenschaften mit Hilfe der Gentechnik zu optimieren, wenn die für die Metallansammlung zuständigen Gene identifiziert seien. Dann bestehe die Möglichkeit, die entsprechenden Gene auf leistungsfähige, aber ungenügende Wirtspflanzen zu übertragen.

Acht verschiedene Arten Hyperakkumulatoren wurden versuchsweise auf kontaminierten Bodenparzellen angepflanzt.