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CAN'T SEE THE TREES FOR THE WOOD

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The attempt to engineer trees genetically belongs to a centuries-old tradition of state and corporate efforts to drastically simplify large wooded landscapes for specialised purposes. Fraught with internal contradictions, this tradition is also under challenge from groups defending local diversity. An effective response to the dangers of genetically modified (GM) trees will go beyond exposes of their biological effects by contributing to alliance-building among these interests.

Most systems of forest stewardship of sustained productivity and value to local people are based on diversity (see box). Such systems often include a mixture of forests, woodlands, agricultural fields, and gathering or hunting grounds arranged in seemingly-irregular patterns which fit local topography and community convenience. They typically feature trees planted or maintained for a variety of purposes including food, shade, erosion control and protection for livestock; fruit, vegetables and wood for humans; and water, nutrients and protection for crops. This diversity of uses generally reflects a local politics in which no single production interest is able to exclude all others. It has a number of beneficial effects – for example, shielding insect species from the selection pressures they would encounter in a monoculture, which often turn them into devastating pests.

In opposition to such systems is an old forestry tradition of centralised control which attempts to create large, simplified wooded landscapes. This tradition stems from the efforts of both early modern European states and large commercial concerns to create, as if from a blueprint, a more uniform forest that was both more legible to bureaucrats and their employees and more *"efficient"* in its production of a single commodity. Systematic seeding, planting and cutting brought into being the ideal commercial *"forest,"* with its grid pattern of similar trees managed according to globally-applicable techniques and free of *"extraneous"* vegetation or human activity. Such *"forests"* – and the industrial plantations which followed – became rigidly separated from agriculture (see box on p3). The multiple functions of ordinary forests were recast as symptoms of untidiness and disorder. Non-wood uses of forests were termed, at best, *"minor forest products,"* while trees whose growth rates had ceased to justify their survival in economic terms were dismissed as *"overmature."* Flora and fauna which reduced output were classified as weeds or pests.

This redefinition of forests was accompanied by a redefinition of rights, as forest societies were partly disassembled. Complicated webs of local rights of access to woods and their varied contents – firewood, mushrooms, fodder, nuts, gravel, peat, game, poles, moss and so on – were curtailed as authorities and firms sought to gain more sweeping legal controls over their productive domains. As seeding, planting, nutrients, growth rates and dates of harvest all came under the control of landowners and industry, a backlash, both biological and social, became evident. Growth rates dropped after first rotations of trees had been harvested; pest infestations increased as genetic diversity dropped; wildlife vanished; and local farmers deprived of part of their livelihoods took to

A MODERN DIVERSITY-BASED FORESTRY SYSTEM

Among at least 400 modern *"community forest"* systems in the hilly upper Northern region of Thailand is that of Mae Khong Saai village in Chiang Mai province. The system features 57 hectares of agricultural fields in which at least 10 different types of paddy rice are grown in stepped fields in the valley bottoms. Some 10 varieties of dryland rice are also cultivated in hill fields, which rotate on a cycle of 3-5 years.

Some 643 hectares of community use forest are carefully distinguished from 980 hectares of protected forest, between them encompassing six different native forest types. Some 58 herbal medicines on which villagers depend are locally cultivated, some in a protected pharmaceutical garden in the middle of the forest. Altogether, forest food and medicine yield the equivalent of US$700 per year for each of the village's 22 households. As well as providing wood for local use, the forests also help preserve the nature of the streams that lace the area, which provide water for agriculture and drinking as well as the 17 carefully-conserved species of fish which supplement the local food supply.

All aspects of the system – agriculture, community-use forest, protected forest, fisheries – are interdependent. The whole pattern, meanwhile, relies for its survival on local villagers' protection. For example, the use of fire is carefully controlled by locals so that devastating blazes don't strike the local forest, as they often do the surrounding region's monoculture tree plantations. Regular monitoring, together with a newly-formalised system of rules and fines covering forest, stream and swidden use, helps maintain balance. Political vigilance is also crucial. In 1969, locals teamed up with concerned government officials to stave off a threat by commercial loggers to devastate the area. Today, Mae Khong Saai villagers are fighting a 1993 government decree ordering them out of the Wildlife Sanctuary which was established in 1978 on the land they inhabit and protect.

Mae Khong Saai's insistence on local stewardship is obviously good for the area's biodiversity – the area is one of the most biologically diverse in Thailand. Animals including bear, dear, gibbon, boar and various wild cats, as well as over 200 species of birds, take advantage of the tapestry of local ecosystems.

Mae Khong Saai couldn't be further from the romantic cliché of a completely isolated, self-sufficient community. As well as marketing forest products, many community members periodically take jobs far outside the community, some in distant cities. In their defence of local livelihoods and the biodiversity they rely on, moreover, Mae Khong Saai's residents depend partly on alliances they have fashioned not only with similar communities across Thailand's northern mountains but also with urban-based NGO movements. Whatever successes its forest stewardship system achieves will owe much to the way it is able to converse and negotiate with lowland and international powers in renewing its strategies for local control.

PULP AND PLANTATIONS

The factory-like order of industrial pulpwood plantations, with their ranks of even-aged trees of the same species marching over large landscapes, is closely tied to the political development of the factory itself. The basic design for the paper machine used today was developed in the 1790s largely as an attempt to transfer control over paper-making knowledge from restive artisans to factory owners. The new device encouraged increased plant scale, increased consumption and centralisation. It also encouraged the use of wood as a raw material, because it was more easily stored, more available and more easily transportable than agricultural wastes or rags, as well as being less labour-intensive.

Reliance on wood helped foster reliance on large, heavily-mechanised and water-, capital- and energy-intensive mills. One outcome was large-scale deforestation and the creation of vast areas of industrial plantations, or *"fields of fibre."* They are increasingly sited in the South, where land is cheaper, growth rates faster, and regulation less restrictive. Here they provide few jobs for local people and have provoked local resistance in countries ranging from Indonesia and Thailand to Portugal and Chile.

The grand scale of pulp and paper operations makes state subsidies indispensable. These take many forms – free infrastructure, tax breaks, cheap land, suppression of local opposition, and/or low-cost university research services. The enormous size of each factory added to the sector, meanwhile, fosters savage boom-and-bust cycles. Paper executives insist that this scale is necessary for *"efficiency."* But even if the issue is disregarded of whether any industry so subsidised can be regarded as *"efficient,"* obvious questions remain. Who or what is this *"efficiency"* for? A typical US citizen uses 60 times more paper than an average Vietnamese, yet the literacy rates of the two countries are virtually the same.

resistance and sabotage. All of these, however, were played down as problems which could be *"mitigated"* through the application of further centrally-administered techniques. Examples included chemical fertiliser and pesticide application; distribution of nesting boxes to replace the hollow trees which birds had previously used; and state repression.

GM trees enter the scene

Politically and institutionally, the genetic engineering of trees is directed mainly at perpetuating the tradition of giant-scale industrial operations, corporate power over the countryside, and biologically homogenised landscapes. Genetic modification offers the opportunity of industrial quality control at a new, molecular level. For example, as long as papermakers were dependent on diverse types of wood waste for raw materials, they had to rely mainly on manufacturing processes to ensure uniform paper quality. With pulpwood plantations, however, variability in the raw material itself could be reduced through choice of species, site, inputs, spacing, and breeding techniques. The genetic engineering of trees is merely another step in this standardising process of linking genes to tree, pulp and paper characteristics. Industrialists now envisage vast plantations of trees not only of a single species, but genetically identical.

One of the most important targets of current research is lignin – the strengthening and protective substance of woody plants. In the production of high-quality paper from cellulose fibres, lignin gets in the way and must be removed with a high expenditure of chemicals and energy. By manipulating the genes which instruct woody plants to manufacture the building blocks of lignin, biotechnologists hope to reduce the proportion of the substance in pulpwood trees, or change it to a less 'troublesome' type. Reducing lignin by as little as 1% would result in savings of many millions of dollars for the industry and would also be useful environmental public relations, since less water, energy and chemicals could be used in pulp recovery. Several US patents have been taken out on GM low-lignin trees.

Genetic engineers also aim to increase the wood density of trees destined for construction materials or paper pulp manufacture; to curb the tendency to branch in trees grown for furniture; to boost growth rates in fuelwood trees; and to engineer fruit trees for altered taste, different ripening characteristics or pharmaceutical production. One biotech company has been set up to market a caffeine-free GM coffee bush which is billed as a means of avoiding industrial processes of manufacturing decaf coffee.

Insect and disease resistance are also important goals. Among the first genes forest biotechnologists exploited were those encoding insecticidal toxins from the soil bacterium *Bacillus thuringiensis (Bt)*. *Bt* genes have been engineered into a wide range of species, including poplar, European larch, white spruce and walnut. Other genes that have been selected to confer insecticidal properties on trees include protease inhibitor genes (from rice and potatoes) that disrupt insect digestion. In order to counter diseases that reduce the yield of fruit tree plantations, biotechnologists are attempting to engineer resistance to plum pox and papaya ringspot viruses. Researchers are also exploring the possibility of creating GM trees that are resistant to fungal disease, such as leaf rust and leaf spot diseases that affect poplar and white pine plantations.

Genetic engineering is also being applied to the problem of soil salinification associated with industrial plantations, particularly those in Australia. Instead of attempting to reduce salinisation, scientists are adjusting the trees' genomes to enable them to survive on the spoiled land. One of the areas of greatest current interest for forest biotechnologists is the engineering of broad-spectrum herbicide resistance. Industrial monocultures are typically established by ploughing up existing vegetation – an expensive process which also results in soil erosion. If broad-spectrum herbicides could be used to clear land without affecting plantation species, business could save an estimated US$975 million per year. Hardwoods are a major focus as they are more vulnerable to herbicides than pine trees. Among the trees that have already been grown in field trials are chestnut, sweetgum and poplar which have been engineered with genes to confer resistance to glyphosate, chlorosulfuron and glufosinate-ammonium (see table over page).

Promising to bypass the need for conventional breeding (a particularly long and costly process with trees due to their long life cycles), genetic engineering is also attractive to wood industries because it extends the breeder's palette to include a range of previously-unavailable traits from other species. Genes from bacteria, for example, can be used to boost trees' resistance to insects, and genes from pine to increase nitrogen uptake and growth rates in poplar. This is another reason why genetic engineering is biased against biodiversity: it claims to reduce the need to conserve native genetic resources for breeding purposes.

GM tree releases in Organisation for Economic Co-operation and Development countries

COMPANY/INSTITUTION	COUNTRY	SPECIES	TRAIT
	Canada	Poplar	Markers
AFOCEL	France	Poplar	Herbicide tolerance
ARS	USA	Plum	Virus resistance
		Walnut	Insect resistance Markers
National Research Institute for Forestry	Germany	Poplar	Marker
University of California	USA	Apple	Altered flowering time Insect resistance
		Walnut	Insect and disease resistance
CEASA	Spain	Eucalyptus	Marker
Connecticut Agricultural Experimental Station	USA	American Chestnut	Disease resistance
Cornell University	USA	Apple	Disease resistance Altered ripening
University of Derby	UK	Apple	Insect resistance Fungus resistance
Dry Creek	USA	Apple	Insect resistance
Finnish Forest Research Institute	Finland	Scots Pine Silver Birch	Markers
University of Hawaii	USA	Papaya	Virus resistance
Horticultural Research, Mt Albert	New Zealand	Apple	Altered fruit ripening
INRA	France	Poplar	Insect resistance Male sterility
INRA-CRO	France	Poplar	Altered lignin Female sterility Herbicide tolerance Disease resistance

COMPANY/INSTITUTION	COUNTRY	SPECIES	TRAIT
Iowa State University	USA	Poplar	Marker
IVIA	Spain	Plum	Virus resistance Male sterility Herbicide tolerance
Michigan Technical Univ.	USA	Poplar	Altered lignin
Monsanto	USA	Poplar	Herbicide tolerance
New York State Exp.Station	USA	Papaya	Virus resistance
Dept of Scientific and Industrial Resources	New Zealand	Kiwi	Markers
Oregon State University	USA	Poplar	Herbicide tolerance Male sterility Disease resistance Insect resistance
Plant Genetics Systems (now Aventis)	Belgium	Poplar	Herbicide tolerance
Queensland Dept of Primary Industry	Australia	Apple	Marker
Sanofi	France	Chestnut	Herbicide tolerance
Shell Research Centre	UK	Eucalyptus	Markers Herbicide tolerance
US Forest Service	USA	Poplar	Disease resistance
Union Camp	USA	Poplar	Enhanced nitrogen uptake Altered cellulose content
		Sweetgum	Herbicide tolerance
Weyerhauser	USA	Poplar	Herbicide tolerance
University of Wisconsin	USA	Poplar Spruce	Insect resistance
Zeneca (now AstraZeneca)	UK	Poplar	Altered Lignin Marker

Source: Biotrack OECD database of field trials. (Last data entered 9 April, 1999).

Following the money

A glance at *who* is instigating, funding, patenting and testing the genetic modification of trees confirms that the technology is strongly biased in favour of the industrial monoculture tradition and against more progressive diversity-based systems of forest stewardship.

Some research is being carried out directly by transnational corporations committed to the industrial plantation tradition. One of the biggest efforts toward making genetic engineering in forestry a reality was a US$60 million joint venture announced in April 1999 between Monsanto and pulp and paper manufacturers International Paper, Westvaco and Fletcher Challenge. The last three companies all have miserable reputations for their forestry operations, toxic releases, or both, while Monsanto is a well-known promoter of large agribusiness monocultures worldwide. The objective of their alliance was to make wood easier to pulp. Although Monsanto has now backed off, restricting its role in the deal to that of a technology provider, the other partners remain in the hope that the new *"designer trees"* will reduce mill costs.

In January 2000 they were joined by the New Zealand company Genesis Research and Development (which specialises in drug discovery and therapeutic vaccines as well as forestry genomics). Fletcher Challenge and Genesis have been in partnership for five years to develop herbicide tolerance in plantation trees such as eucalyptus, poplar and pine. The two firms have also been granted a US patent to alter the lignin content of trees. Japanese paper and auto firms are also carrying out research into the genetic manipulation of trees. In addition, transnational corporations are stumping up money to pay university researchers in a number of countries to carry out investigations into tree biotechnology.

The bulk of basic research, however, is likely to be funded by corporate-friendly government agencies working together with industry associations and universities. This better suits the conservative orientation of many wood industries, who favour the time-tested corporate strategy of shifting research costs off on the public sector wherever possible. The Tree Genetic Engineering Research Cooperative (TGERC) based at Oregon State University in the US is a good example. TGERC is responsible for researching and testing trees genetically modified for improved fibre production, herbicide tolerance and resistance to fungus and insects. It receives funding from the US Department of Energy Biofuels Program, the US Department of Agriculture, and the US Environmental Protection Agency; paper and timber companies such as International Paper, Weyerhaeuser, Boise Cascade, Georgia-Pacific, Union Camp and MacMillan Bloedel; the Electric Power Research Institute, a utility industry association; other firms such as Monsanto and Shell; and Oregon State University itself. Providing technical and logistical support are the US and Canadian Forest Services, Mycogen, the University of Washington, and Washington State University. This wide collaboration, in TGERC's own words, results in a *"leverage factor of nearly 40-fold for individual industrial members."*

The more money is available for tree biotech research, of course, the less incentive foresters have to study other areas – a heavy irony, given that while the complexity of forest ecology and tree genetics is well recognised, they are poorly understood and starved of research funding.

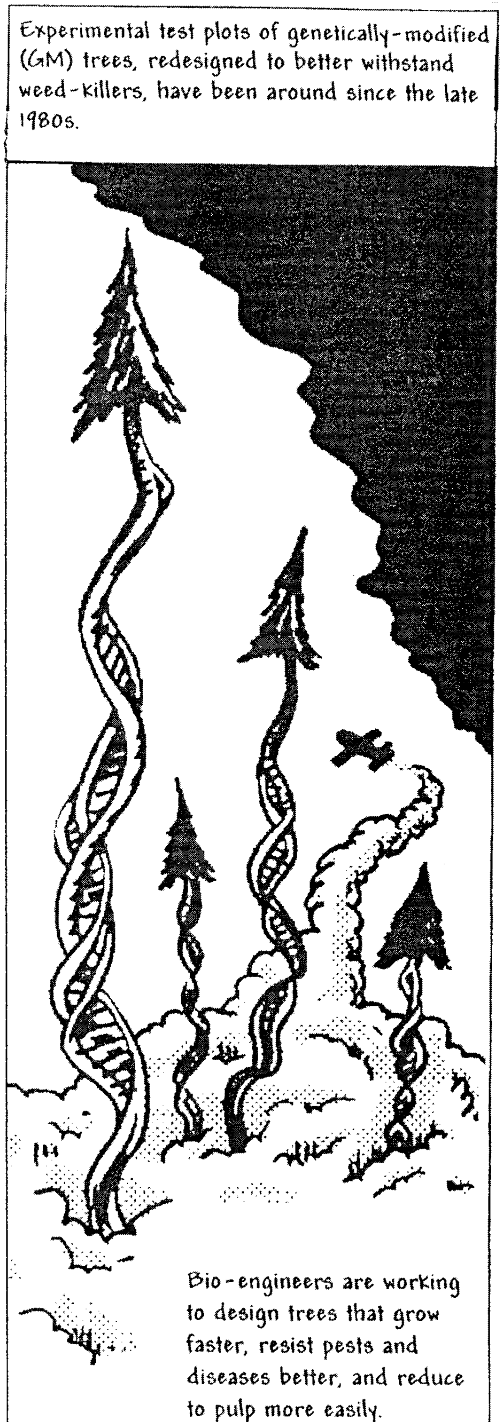
The "technofix" dilemma

The genetic engineering of new traits into trees can be expected only to deepen the familiar environmental and social havoc characteristic of the industrial monoculture tradition:

Lignin-reduced trees
These are likely to have multiple deleterious effects given lignin's multifunctionality. Lignin reduction may weaken trees structurally, and some researchers have reported stunted growth and collapsed vessels, leaf abnormalities and an increase in vulnerability to viral infection. Because lignin protects trees from feeding insects, low-lignin trees are also likely to be more susceptible to insect damage, leading to pressures to increase pesticide use. Low-lignin trees will also rot more readily – affecting soil structure, fertiliser use, and forest ecology – and will release carbon dioxide more quickly into the atmosphere.

Insecticide-producing trees
GM trees that produce their own insecticide will exacerbate the problem of resistance and kill off natural predators, making the problem worse instead of better. In addition, some newly-resistant insects could simultaneously evolve a capability to expand their feeding range to previously less-susceptible plant species. Unexpected pesticide contamination of ecosystems is also possible. The insecticidal *Bt* which certain agricultural crops have been engineered to produce, for example, has unexpectedly been found to be capable of being exuded through roots and binding with soil particles, persisting in the soil for 243 days and remaining toxic for very long periods. Finally, as long as they enjoy an advantage over trees susceptible to insect feeding, insecticide-producing trees will be able to invade wilder systems with ease, disrupting their insect population dynamics.

Disease-resistant trees
Trees genetically modified for resistance to disease are likely to cause fresh epidemics. Genetic diversity within stands is well-recognised as essential to tree health in sustainable forestry, yet genetic diversity will be lower than ever in GM plantations. Second,

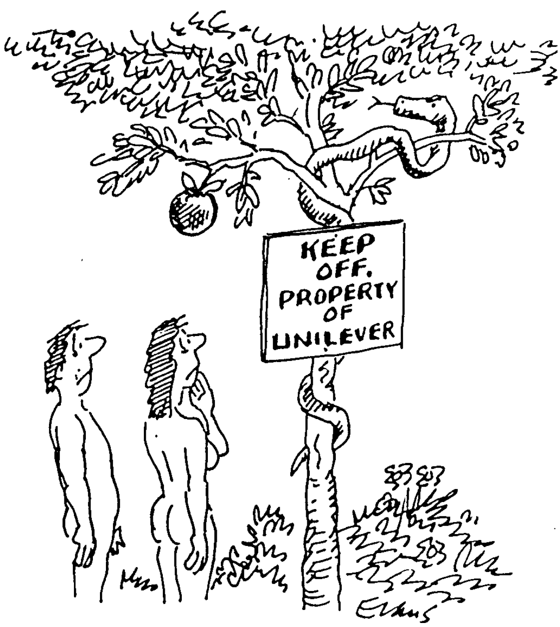


ASEED

fungicide production engineered into GM trees to help them counter such afflictions as leaf rust and leaf spot diseases may dangerously alter soil ecology, decay processes and the ability for the GM trees to efficiently take up nutrients efficiently. Third, it has also been shown that GM virus resistance may accelerate the evolution of new diseases.

Herbicide-resistant trees

Trees genetically engineered to be tolerant of herbicides will further entrench the use of the chemicals in corporate and state attempts to create wooded landscapes free of *"extraneous"* species. Broad-spectrum herbicides damage soil structure and fertility through changes in root systems, soil insect populations and soil food webs. Herbicide use has also been shown to increase agricultural crops' susceptibility to disease. As bacteria and fungi which promote soil health decline through herbicide use, vegetation-damaging bacteria and fungi move in. Ultimately, the use of other pesticides to combat fungal diseases may increase.



Phil Evans: Channel 4's "Commodities"

Herbicides are also dangerous to birds and other animals that rely on a diversity of plants for food and shelter. Their use over prolonged periods diminishes food sources for the species dependent on them and provides ideal conditions for the evolution of herbicide-tolerant plants and the need for higher doses and even more hazardous chemicals. Despite manufacturers' claims of 'environmental friendliness', moreover, glyphosate, the active ingredient of favoured plantation herbicides (including Round-Up), binds to soils in the same way as inorganic phosphates and may remain undegraded for years, endangering aquatic life. Glyphosate also disrupts the healthy balance of soil life and kills beneficial insects including wasps, lacewings and ladybirds. GM glyphosate-tolerant trees have been grown in field trials throughout the 1990's in USA, Europe and South Africa.

Trees in a hurry

Trees genetically modified for faster growth are likely to use up water even faster than the fast-growing trees currently used in industrial plantations, exacerbating problems of dryout and salinification which undermine the livelihoods of people living on adjacent land. Such trees will also suck up nutrients at a higher rate, necessitating the application of an ever-increasing volume of chemical fertilisers. Hence fast-growing GM trees may speed up the process by which previously rich land is impoverished. Trees genetically modified for fast growth will also be highly invasive of ecosystems for which they were not intended, quickly overtaking slower-growing non-GM trees in the competition for light and nutrients. They will thus threaten not only wild and endangered tree populations but also the plants, insects, fungi, animals and birds that have evolved to fill specialist niches dependent on those populations. For example, Swedish researchers engineered aspen with a gene from oats which controls the response of plants to day length. The resulting tree was able to grow during winter daylengths as well as summer. Had the GM aspen not unexpectedly lost its ability to withstand cold in the process, it would have had a huge advantage over other trees. Fast-growing trees with improved ability to take up nitrogen compounds from soil can also be an invasive ecological threat. A (non-GM) nitrogen-fixing tree introduced to Hawaii provides one cautionary example. The tree has pumped a normally nutrient-impoverished lava ecosystem so full of nutrients that a number of diverse and specially-adapted native plant communities have been driven out.

Protagonists see GM trees as a panacea for all sorts of planetary problems. The US Department of Energy and others have ambitions for carbon-dioxide absorbing GM trees to counter climate disruption. Similar grandiose proposals call for genetically *"manipulating"* terrestrial ecosystems so that they can temporarily store several times more carbon than at present, in order to make possible *"continued large-scale use of fossil fuels."* One result could be the creation of vast plantations of trees genetically engineered for both faster growth (to absorb carbon dioxide from the atmosphere more quickly) and higher lignin content (for more stable storage of the sequestered carbon). The consequences would include not only the social effects associated with the seizure and degradation of huge areas of forest lands and their soils, but also the entrenchment of a wasteful energy economy elsewhere. If allowed to decay or be used for fuel or paper, of course, the trees would quickly release the carbon they had temporarily sequestered back to the atmosphere.

Genetic colonisation

Nowhere are the contradictions of the GM *"fix"* clearer than in the controversy over how to prevent GM organisms from spreading from industrial to neighbouring ecosystems. Because trees are even more genetically compatible with their wild relatives than highly-bred agricultural crops, GM escapes are especially worrisome in forestry. Isolation is virtually impossible. Plantations often border wild forest systems, and are often established on land cleared of old-growth forest.

Tree pollen can also travel vast distances. In Northwest India, windborne pine pollen was found 600 km from the nearest pine trees. Crucial forest pollinators are also notably indifferent to posted boundaries between GM and non-GM domains. Seeds are equally difficult to limit. In fact, it is seed or vegetative fragments which feature in the best-documented cases of long-distance gene flow, for example the establishment of plants on new continents. Many trees can also spread through the distribution of broken twigs, while others send suckers up from their root systems. A single aspen in Utah (USA), for example, boasts 47,000 trunks springing from its root system, and covers 42 hectares. Trees can also grow from stumps left after felling. In sum, trees may be even more adept at spreading their progeny than crops, and once in the wild, a single GM tree could survive for hundreds (perhaps thousands) of years.

A cascade of technical fixes

Within the industrial plantation political system, for each fresh problem created by attempts to fix previous problems tends to stimulate funding to research yet further, higher-order fixes. The result is a continuous cascade of ingenuity-absorbing technical tweaks fated to generate still further problems.

Thus one *"solution"* to the dilemma of genetic invasion is to attempt to engineer trees for sterility to prevent gene flow. Predictably, however, this second-order fix leads immediately to difficulties requiring a third-order fix, and so on. GM sterility, for example, cannot be guaranteed to be permanent over generations and through environmental changes and disease stresses. Nor does engineered sterility prevent gene flow through horizontal transfer (for example to bacteria and fungi), or through vegetative propagation, such as twig and stump re-growth or suckers. Moreover, stands of sterile trees devoid of birds, insects or mammals that rely on tree seeds, pollen or nectar for food could disrupt population dynamics, with severe impacts on adjacent wild systems.

Current regulatory requirements for risk assessment are a further example of an attempt at a higher-order technical fix – one quickly beset by its own limitations and dilemmas. For one thing, much of the data which adequate risk assessment of GM trees demands is unobtainable. For instance, in practice it is not possible to measure accurately to what extent GM plants or their genes might spread, simply because of the sheer size of the area which would need to be thoroughly examined for migrants. Second, serious risk assessment would exclude GM trees from precisely those uses for which they are being principally developed. For example, Professor Kenneth Raffa at the University of Wisconsin suggests that risks related to the evolution of insect resistance can be limited if large or homogenous plantations are avoided – a recommendation inherently at odds with the industry's requirements

In addition, the long life cycles of trees and the range of seasonal and other environmental stresses that they have to withstand entail that any genetic modifications made to them may be unstable. This too militates against reliable risk assessment. Each stage of a tree's lifecycle is characterised by a cascade of previously unused genes or gene combinations – those that act in concert to direct flower formation or fruit ripening, for example. Determining how these interact with the engineered gene could take several years to ascertain — a timescale unlikely to be acceptable to shareholders or even many environmental risk assessors. Unforeseen results are common. Aspen, for instance, will usually not flower before its seventh year, and German authorities gave consent for a five-year open field trial of GM aspen trees on the assumption that they would not flower before the trial had finished. Unexpectedly, however, one of the trees started flowering in its third year, despite pre-trial findings hinting that GM aspen would grow more slowly than non-GM aspen.

Given the threat to the development of forestry biotech which rational assessment would pose, it is small wonder that proponents such as Simon Bright of Zeneca Agrochemicals are driven on occasion to articulate the defensive demand that questions about GM trees be *"framed in a way that gets a positive answer, or that a positive answer is allowed."* The agencies currently undertaking risk assessment of GM trees are often the ones with a vested interest in supplying just that positive answer. In Canada the Canadian Forest Service both promotes GM research and checks for risks, while Oregon State University's TGERC program, whose future lies in promoting GM trees, is precisely the body the US Environmental Protection Agency has chosen to assess the dangers of the technology. This pattern hardly bodes well for forest ecosystems and the people whose livelihoods depend directly on them.

Conclusion

The framework through which genetically-engineered trees are being developed is profoundly biased against social arrangements which promote and rely on biological diversity. This framework is also riven by destructive tendencies which chains of technical refinements are likely to be powerless to overcome. Tackling the challenge GM trees pose means tackling the industrial and bureaucratic tradition which seeks the radical simplification of landscapes. That entails alliance-building with groups working against and outside that tradition.

The issues raised by GM trees are similar to those raised by GM crops. Yet in many ways, genetic modification in forestry is an even more serious issue than in agriculture. Trees' long lives and largely undomesticated status, their poorly understood biology and lifecycles, the complexity and fragility of forest ecosystems, and corporate and state control over enormous areas of forest land on which GM trees could be planted combine to create risks which are unique. The biosafety and social implications of the application of genetic engineering to forestry are grave enough to warrant an immediate halt to releases of GM trees.⌘

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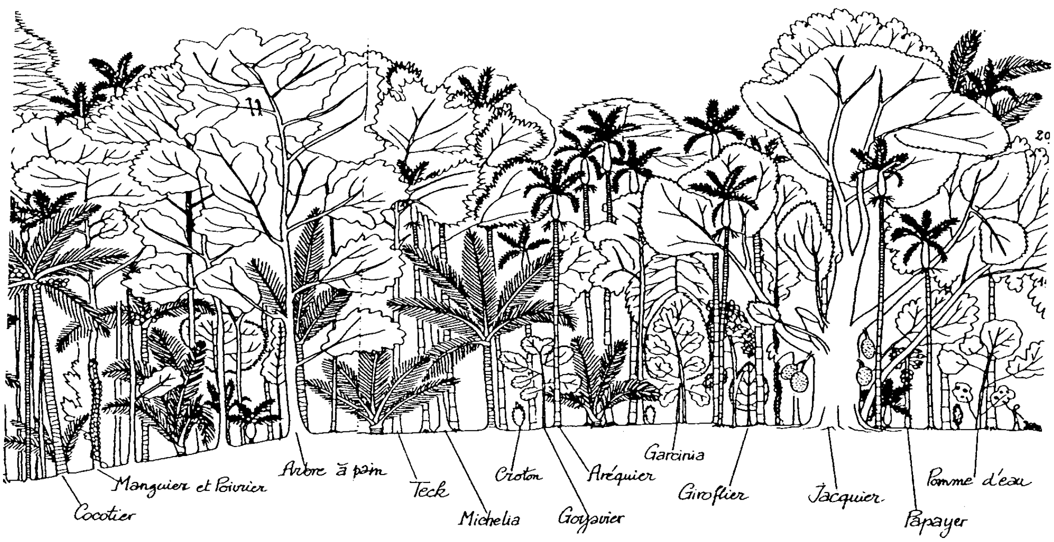


Solagral

URUGUAY'S DESTRUCTIVE PLANTATION MODEL

CARLOS PÉREZ ARRARTE

Uruguay has been earmarked for dramatic expansion of its tree plantations. The government has plans to plant some 20% of the country to eucalyptus and pine plantations to generate export revenues. Such a move will have tremendous implications for the traditional gaucho lifestyle, rural livelihoods, the environment and biodiversity. Transforming prairie land into plantations may prove to be an irreversible choice, and the implications need to be thought through carefully.

Over the past 15 years, the policy of introducing large-scale plantations of domesticated or specially bred trees has been changing the face of forestry in the southern hemisphere. It has also allowed the relocation of the pulp and timber industries towards the periphery. In Latin America, this process was lead by Brazil and Chile, but now a number of other countries are competing to attract foreign capital into the forestry business. The expansion of tree plantations reflects the following trends:

- The native forests of the Northern Hemisphere, under grave threat from acid rain, commercial logging and urban development, are at the same time increasingly valued for the environmental services they render;
- The rainforests are disappearing at an ever-increasing pace;
- Per capita world consumption of timber and wood, paper and other pulp sub-products continues to increase rapidly.

From the centres of power – the multilateral financial institutions and via international technical cooperation – a message is going out selling the value of tree plantations to protect natural resources and the climate. They simultaneously point out what splendid opportunities plantations offer to do business in a supposedly sustainable way. However, this new plantation agriculture brings a series of impacts on land use, on the environment, and on society and the economy in general. In this article we examine the case of Uruguay, a country with a prairie landscape which has been undergoing a plantation boom for ten years.

Prairies, woodlands and cattle

Lying between its two great neighbours, Brazil and Argentina, Uruguay's territory is part of the pampas prairie lands which are the characteristic formation of a vast region in the Southern Cone of South America. The landscape is gently rolling, the climate is humid and sub-tropical, and the best soils are both deep and fertile with a low risk of erosion. A quarter of the land is used for agriculture.

The region´s highly complex and biologically diversified climax vegetation consists of prairie grasslands in which lawn and creeping grass varieties prevail. These comprise overall approximately 2,500 different species, distributed in over 80 families, including more than 400 species from the *graminaceae* family. Despite the impact of grazing by cattle, sheep and horses over the past three centuries, the native grassland has shown a remarkable capacity to adapt and retain its biological and economic sustainability. In the past, the prairies formed the principal pillar of Uruguay's economic development as well as of its social and political history. Even today, native pasture still accounts for over 80% of land use and remains as important as ever for Uruguay's export trade (meat, wool, leather and dairy).

Extensive outdoor cattle-raising has been the principal productive system since colonial times, in a relatively harmonious relationship with the available natural resources. All-year-round grazing for cattle, sheep and horses in extensive enclosures has characterised the *"estancias ganaderas"* (cattle ranches) that typify the landscape, with the "*gaucho"* (horseman) as the emblematic social player. Uruguay quickly reached levels of self-sufficiency in agricultural foodstuffs. Early in the 20th century, it was already a net exporter of foodstuffs and vegetable and animal fibres.

The prairie landscape also includes native forests, found along the banks of rivers and streams and in the rocky hilly areas. These are composed of a wide variety of species, well-adapted to the natural conditions and the pressure of grazing animals. About 100 species of trees and 100 species of bushes make up the flora of the country's native woods, which make up about 3.5% of the total land area. These woods have historically been used to provide firewood, fencing, and building materials as well as offering a variety of ecological services.

Slow incubation, fast growth

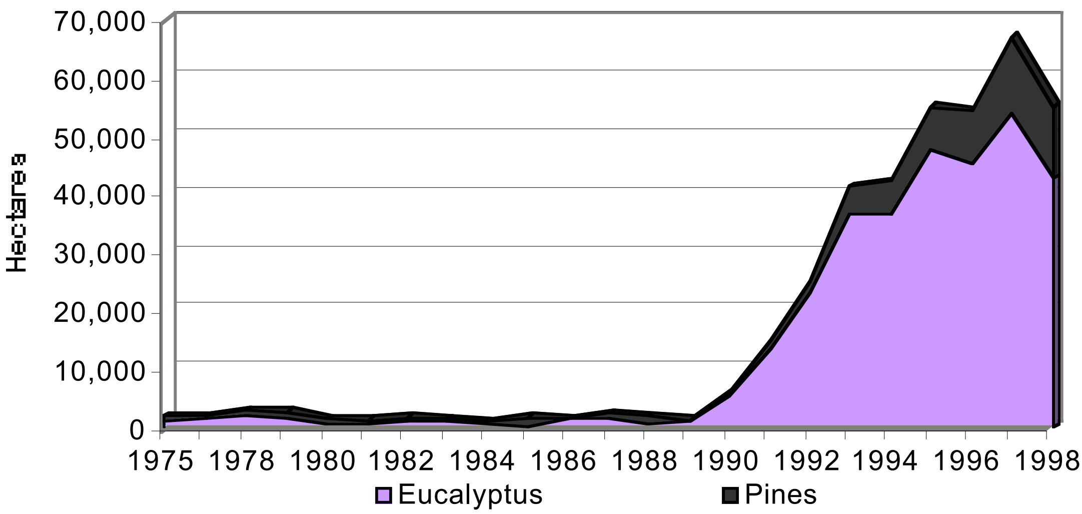
Eucalyptus trees of Australian origin were first introduced in 1853. Plantations expanded rapidly during the 20th century with the main aim of providing shelter to cattle, as well as firewood, building materials and other services related to cattle-ranching. These plantations took the form of small copses of about one hectare in area, or as 2 to 4 rows of trees planted as windbreaks throughout the country which became an integral component of the landscape.

In the late 1960s, a series of incentives to develop tree plantations boosted growth, resulting in average annual increases of 2-3,000 hectares of new plantations. The enactment of the new forestry law in 1987 led to a further increase in new areas, which are now being added to at the rate of 50,000 hectares of plantations each year (see graph over page). These plantations are predominantly limited to a very narrow range of species: two varieties of eucalyptus – *globulus* and *grandis* – and two varieties of pines – *elliottii* and *taeda*. Within the framework of these forestry laws, and with management strategies designed to produce wood for industry, about 450,000 hectares of trees have been planted during the past few years. Adding in the 140,000 hectares of previously existing plantations and 650,000 hectares of native woodlands, the result is some 7% of the land covered with native or exotic trees.

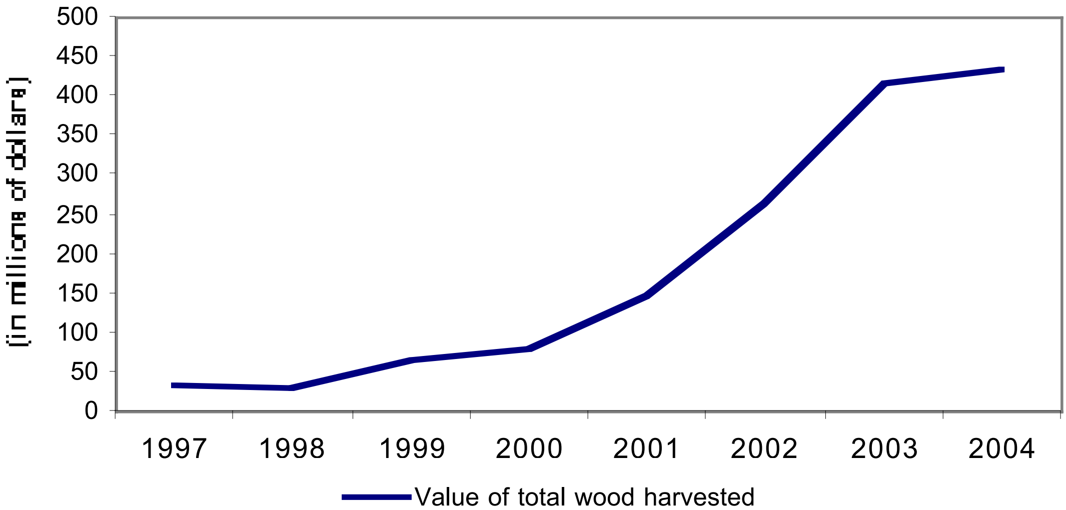
The government has big plans for its forestry sector. During a trip to Chile in March 2000, aiming to attract Chilean forestry investors, the President of Uruguay outlined a potential area for forestry plantations of 3 million hectares, or 20% of the national territory. Estimates of the timber to be harvested over the next 20 years suggest that 90% will be eucalyptus and the remaining 10% of pine. Pine is destined for the saw mills, while 70% of the eucalyptus will go for pulp with the remaining 30% for saw mills. Originally, Uruguay's forestry policy was designed to produce eucalyptus trees to produce woodpulp. Over the past two years, however, awareness has grown as to the difficulties which this strategic option may bring, and North American investors have been opting for pine plantations instead.

There is a wide range of social agents involved in the forestry sector, from giant transnational companies with many thousands of hectares, to small independent planters with 20 to 50 hectares. Owing to the scale of their

Plantation growth in Uruguay from 1975-1998



Projected Evolution of Harvest-Ready Plantations



investments, their levels of productivity, their technologies, their vertical integration overseas and their social and political influence, transnational corporations have a strong influence on the sector. The arrival of these companies marked a turning point in Uruguay's history, because up till then big corporations had played a very limited role in agricultural production. A second significant group amongst the investors in plantations are the Chilean investors, who turned to Uruguay in search for more permissive investment opportunities, in response to an increasingly hostile environment to plantations in Chile

Local capital also plays a role. Two national pension schemes made considerable investments in tree plantations before the enactment of the present legislation. More recently, forestry investment funds establish plantations and divide them into many individual lots which are then put onto the market. Forestry service companies provide tree nurseries, tree planting and pruning services, export opportunities and technical services

Laying the plans

The forestry sector is a prime example of the development model established by the three governments which have been in power since democracy was re-established in 1985. Production is export-driven and follows the directives of, and benefits from, the credit facilities of multilateral financial institutions.

The various fiscal incentives are channeled to those plantations established on *"forestry priority land"* (see box). Up to 1997, subsidies and tax exemptions amounted to about U$S350 per hectare (without counting other benefits which were only applied to certain firms as part of the overseas debt cancellation mechanism for direct investments). Multilateral financial institutions were essential for the expansion of the Uruguayan forestry sector. Additionally, the

BENEFITS ENJOYED BY THE FORESTRY SECTOR IN URUGUAY

* Tax exemptions for plantations and forestry companies for a period of 12 years after the plantation has been established, including protection from any new taxes which may be created and which may tax plantations generically. This means that forestry firms are exonerated from all of the principal taxes paid by ordinary agricultural establishments.
* Companies involved in forestry or the industrialisation of wood and timber are exempted from all import duties payable on machinery and other inputs for a period of 15 years from the date of the enactment of the 1987 forestry law.
* Direct subsidies are granted to plantations established in the forestry priority areas, provided each new project is approved by the Forestry Department. This subsidy covers approximately 50% of the cost of establishing the plantation. At the present time, this is valued at approximately U$S160 per hectare.
* Companies are allowed to register as *"Sociedad Anónima"* (public limited company, or Incorporated), something that is not allowed otherwise in the agricultural sector.
* Forestry firms benefit from long-term (12 to 15 years) credit facilities with the National State Bank, Banco de la República, with a period of grace for repayment of interest and capital until the trees get harvested.
* A one third reduction in port fees for the movement of timber

Japanese International Cooperation Agency (JICA), played a major role in the preparation of a national plantation plan in 1986 aimed at the establishment of 420,000 hectares of eucalyptus and pines over a period of 30 years.

In 1997 a new project was approved: *"The Transport of Forestry Products,"* totalling U$S152 million, with 50% funding from the World Bank and 50% from the Uruguayan government. In the same year, the Interamerican Development Bank (IDB) also approved a U$S176 million transport programme which would largely benefit the forestry sector.

Eleven years since the enactment of the Forestry Programme, and after numerous alarm calls from independent researchers and university or non-governmental organisations have been made, neither the Bank nor the Government has commissioned a significant study on the overall impacts of afforestation on the country's natural resources. Neither have they examined the possible combined impacts which may arise when these plantations impact on other activities: for example, projects for the supply of hydroelectric energy, provision of drinking water to urban centres, the development of irrigation for rice-growing and so on.

The first eucalyptus plantations established under the prevailing law of 1987 are now reaching maturity, and are almost ready for harvest. Given that the area under plantation has increased from the initial 3,000 new hectares per annum to the present 50,000 hectares per annum, the volumes of timber harvested will increase rapidly over the next few years (see graph on p16). From 638,000 cubic metres harvested in 1997, it is projected to reach 1.6 million cu. metres in 2000 and 8.7 million in 2004.

In Uruguay there are no plans to set up the infrastructure for the industrial production of paper pulp. In the medium term, therefore, the vast majority of the plantation production will be exported in the form of logs and, to some extent, wood chips, to supply the pulp industries with their raw materials. The most likely destination is the North Atlantic, basically the Iberian Peninsula, and, to a lesser extent, the Scandinavian countries. Regional integration as well as regional forestry development – in the State of Rio Grande do Sul in Brazil, and in the provinces of Entre Rios, Corrientes and Misiones in Argentina – may dramatically alter the present scenarios. These areas, and Chile and Paraguay too, are competing strongly to attract foreign corporate investors.

Recently, some modern industrial plants, saw mills and drying facilities have been established to process wood-products with a higher added value, such as high quality *"clear"* timber, blocks, blanks, and laminates which are beginning to open markets overseas and are already contributing significantly to export earnings. These products are obtained from pine and eucalyptus *grandis* plantations specially managed for industrial timber purposes.

Transport needs will put great pressure on the country's physical infrastructure. A number of strategic routes will require repairs, rebuilding and re-structuring. Some of these activities have already begun, but the country has not yet fully realised how short a time remains before the product comes on the market, nor the enormity of the logistical problems which handling it will entail in the near future.

Goodbye to the rural landscape

In the regions where the *"forestry priority"* land is concentrated, plantations have become the main type of land use. This is having a significant impact on traditional social structures. In cattle-raising areas, the price of land has risen, the ownership of productive resources has become more concentrated, there has been an initial increase in the demand for labour (particularly, for female workers in tree nurseries) and for the provision of services (transport, housing, etc.), land taxes are no longer received by the local municipal governments, and some traditional forms of production have been displaced. Roads have been impacted by the increase in transport, and this in turn is affecting the local people or local governments responsible for their maintenance.

As regards local power structures, the agrarian community is faced with the arrival of new players with a huge economic capacity, who are courted by the local authorities. Their presence is establishing a social rift of such magnitude that integration into local society is proving extremely difficult. In some small localities, these new companies are totally monopolising the local labour market and local services, and their middle-management are transforming public administration and political power structures to serve their own needs.

Only those plantations intended for the production of quality timber – currently less than a quarter of the forested area – have continuous significant labour requirements (for pruning and thinning) in the long term. Otherwise, the forestry sector uses a high proportion of seasonal labour with poor working conditions, scant observance of social security laws, and high accident risk. These working conditions arise because the companies usually contract out to sub-contractors who provide *"forestry services"* using informal labour.

Sucking up the lifeblood

Tree plantations result in the replacement of the original climax biotic system (the pampas) with uniform tree cover, composed of one identically-aged species in initial densities of 1,000 and 1,200 trees per hectare, with none of the accompanying undergrowth that would have existed in the countries where the exotic species originated. Over their 20-30 year growth cycles, commercial tree plantations eliminate all the original vegetation and its associated fauna, posing the question of how reversible this form of land-use may be in the future. There is a dramatic contrast between a single-species system of vegetation composed of identically-aged trees, and a multi-species prairie system.

In terms of biodiversity, this process is equivalent to the deforestation of the Amazonian rainforest where new frontiers are being opened up for tropical cattle-ranching. Except that in Uruguay, the process is happening the other way round: the destruction of a natural ecosystem (the prairie grasslands, with their multiple associated environmental services) that is highly suitable for cattle raising, to produce tree monocultures. Furthermore, for three centuries, this prairie grassland has been the basis of a sustainable productive system on which the entire structure of Uruguayan society and its economy has rested.

Trees require less fertile soils than prairies, especially conifers and those associated with *mycorrhizae*. Over time, the soil becomes less fertile than that in prairie systems. Changes can be expected with regard to the type and distribution of organic matter in the soil profile, in the carbon-nitrogen relationship, besides the acidification of the soils and the production of *complexifying* substances (i.e. aluminium and iron composites).

Parallel to this, trees need more water than prairie grasses. When exotic trees are introduced, less water will be left for other uses and the water table will be depleted. Important changes can be expected in the various components of the water cycle. It is estimated that a eucalyptus plantation will have a 30-50% greater evapo-transpiration level than a native grassland. The forestry plantations will also significantly affect the amount of surface run-off, reducing it by about 2,500 cubic metres per hectare/per annum. Equally, the degree of interception of rainfall caused by the foliage of a prairie under grazing and a plantation of ten-year old pine trees is dramatically different. What impacts will these changes have on the productivity of the basin of the River Santa Lucía, which is responsible for supplying the drinking water of Montevideo's entire metropolitan area where 60% of the country's population lives? Or on the operations of the hydroelectric plant on the River Negro – along which large-scale afforestation is taking place – where three dams supply the bulk of Uruguay's energy supply? Similarly, conflicts with rice-growers dependent on irrigation can be expected, since they rely mainly on surface run-off water.

In 1997, under pressure from environmental organisations, the Forestry Department commissioned its first study of the environmental impacts of tree plantations. As a result of its recommendations, monitoring of sample micro-river basins has begun in order to gather local information to respond to some of the above questions. Other more complex impacts are not yet on the agendas of academic research programmes. For example, changes in air circulation over this type of landscape, on micro-climates, on the cycles of carbon and other nutrients, on soil morphology, or somewhat surprisingly, on the relation between ranching and forestry. Some forestry companies have also begun their own research: certain lines of genetically-modified (GM), herbicide-resistant eucalyptus are being reproduced in the country, with the expectation that these will eventually lead to a reduction in cultivation costs (see article in this issue on GM trees).

Local people have reported many environmental impacts. There have been many complaints about the damage caused by birds such as parakeets and doves which nest in the trees. Ranchers complain of the damage caused to lambs and calves by wild boars, foxes and other animals which find shelter in the plantations. Local communities worry about the proliferation of poisonous snakes in some areas, and have serious concerns about forest fires. There is considerable scepticism about the ability to fight fires on the scale of today's plantations.

Visual pollution is probably an underated concern. The native rural inhabitant, with his or her roots in the *gaucho* culture of the pampas, has always appreciated being able to move freely across the territory, roaming on horseback with the sight of the distant horizon far ahead. Another impact has to do with the various effects afforestation will have on agro-tourism, an activity which is undergoing a considerable expansion at the present time, and one which is thought to have a good potential for the future development of rural Uruguay.

The impact tree plantations are having on the landscape and people of Uruguay is also being suffered in many countries around the world. In the box at the end of this article we are including some options being explored by organizations from the South and North, in order to better counter the negative impact of afforestation and develop viable alternatives.

Conclusions

The multilateral banks favour the plantation forestry model for Uruguay because of the particular conditions offered by its humid, sub-tropical climate. The dominant prairie ecosystem is extremely biologically diverse but is not adequately valued in the global system. After being identified by the World Bank in particular as being a suitable candidate, this forestry model has been applied with hardly any modifications in a country with scarce traditions of forestry, not ideally the best ecosystems for the plantation model and limited infrastructure for product exploitation and handling. Over the past two years, and with the maturity and harvest of the first plantations looming large, successive loans are being made available to develop the infrastructure which will be required to develop the national transport and port terminal systems, without any questions being asked about the suitability of the current model. Meanwhile, the plantations continue to spread.

Internationally, as a marketing strategy to promote agricultural and meat products as well as tourist services, academics, and rural and political leaders are presenting Uruguay as a *"natural country,"* because of its privileged range of natural resources and their relatively limited degree of transformation compared with other societies with a similar level of development. The artificial tree plantations will play a negative role in the construction of this image. However, Uruguay's afforestation programme looks appealling within the framework of the North's interest in creating *"carbon sinks."*, but the country will experience a heavy toll in environmental and social terms.⌘

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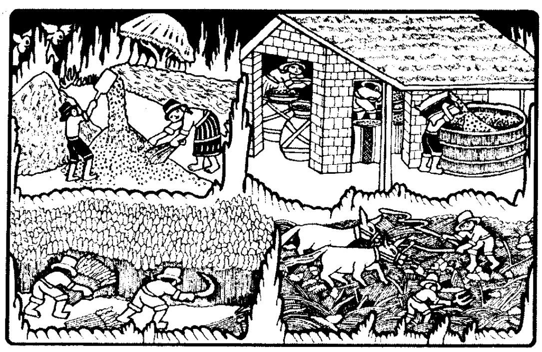
CICDA

LOOKING TO THE FUTURE

1) Alternatives and control at the community level:
Only through close contact with popular movements can people interested in 'alternatives' really find them. Local communities disposed of their resources by industrial plantations must have a central role in the search for alternatives.

2) Small-scale and local paper production:
China still supplies its immense paper needs largely through small local mills which use surplus local agricultural wastes such as straw. These mills support community economies and require no advanced infrastructure to support them. Paper manufacturing expert AW Western has argued that in India and other Southern countries, *"detailed comparisons between the large mill and the equivalent capacity in small mills overwhelmingly favour the smaller unit in economic terms."* According to researcher Maureen Smith, there are no serious obstacles even to current US paper and paperboard consumption being met by a more decentralised network of small- to medium-sized mills using approximately half waste paper and half non-wood crops.

3) Urgent working propositions:
- Large monoculture industrial tree plantations are socially and environmentally unsustainable.
- Local people must have the right to veto land uses and manufacturing processes they do not accept.
- Ways must be found of promoting existing ways of decentralising pulp and paper manufacture, making it more receptive to local needs and plans, reducing its scale and dependency on vast amounts of a single, standardised commodity such as wood, and lowering demand, particularly in the North.
- Large industrial tree plantations cannot be fruitfully discussed in isolation from the global economic and social realities of which they form a part. The issues they raise are political, not merely technical.

4) International solidarity and alliances:
Southern groups may share information and strategic thinking with other Southern groups within a region or across the globe. Southern groups may also offer insights to Northern movements, as has happened in the Nordic countries, whose growing forest networks have benefited considerably from the lessons learned from the South. Northern groups can also play an important supporting role in Southern groups' attempts to curb the damage done by plantations. They can, for example, monitor the plantation-promoting activities of the bilateral 'aid' agencies, consultancies, commercial development investment agencies and transnational corporations based in their countries.

Taken from: Ricardo Carrere and Larry Lohmann, *Pulping the South: Industrial tree plantations and the world paper economy.* Zed Books Ltd, London, 1996.

POTATO: A FRAGILE GIFT FROM THE ANDES

GRAIN

Having travelled the world for several centuries, the humble potato is heading home to the Andes in South America. But the returning traveller looks very different from the one that the Spaniards ran off with in the 16th century. It is tired and weak after being tinkered with by European and US plant breeders, who fashioned it into a tuber to serve the needs of the fast food industry and industrial agriculture. What is the future for this transformed potato, with its faded genes, in the South?

Often characterised as a poor man's staple, the so-called *"humble"* potato is actually a kingly food. Producing more calories and high quality protein per square metre than any other major food plant, it can be grown in as little as 60 days. This treasure of the Incan empire is the world's third most important crop for human consumption. But it comes with a price: it is the world's most stress-susceptible and chemical-dependent major crop.

Potatoes have traditionally been consumed fresh, and they are sown out of potato tubers rather than from seeds, which means that they are especially prone to disease. Because of this, international potato trade has been severely limited by phytosanitary measures. But in the hands of the fast-food industry, which is increasingly controlling production in the North and now the South, the potato is becoming quite the global traveller. Over the last few decades, developing countries have increased their share of global output from 11% (1961-63) to 37% (1995-1997). Some of this increase is due to some countries (such as Egypt) exporting off-season seed and edible potato to Northern markets. But much of it has arisen from the promotion of potato by the International Potato Center (CIP). CIP has promoted potato in Africa and Asia as a key element for countries' food security. Production may have increased, but what about food security? Is the industrialised version of the potato really a suitable crop for small and traditional farmers in the South to invest their energy and resources in?

Andean roots

The Andean zone is one of the world's main centres of plant domestication and diversity and the home of the potato (see box over page). Mexico is a second centre of diversity. As soon as human populations started farming in the region, they began cultivating diverse species of potatoes (*Solanum sp.*), while also gathering and eating wild tubers. No other major food crop enjoys as high a genetic diversity within its cultivated species and wild relatives as potato. While for most of the rest of the world the potato crop depends on a single species (*Solanum tuberosum)*, in the Andes at least nine different *Solanum* species are cultivated. Wild relatives provide a further 226 species.

Potatoes are grown in most of the crop zones in the Andes, and they dominate the upper zones, between 3,000m and 4,000m above sea level. The *Aymara* people alone developed more than 200 varieties on the Titicaca Plateau at elevations higher than 3,800m. Andean farmers distinguish between two main types of potato. Bitter, frost-resistant *haya papa* are planted at high altitudes. *Mikhuna papa* types, without bitter compounds, are planted in mid-altitudes.

ANDEAN FARMERS' GENETIC WEALTH

The 5,000 Andean potato varieties CIP has identified bear witness to the key role played by biodiversity in traditional Andean potato growing. A 1998 study undertaken by two Bolivian universities found that a 450-strong community near Cochabamba maintained 70 potato varieties or ecotypes from five potato species. Single families held up to 31 potato varieties, with most keeping 7 to 13 varieties. The study confirmed that farmers' intimate knowledge of their mountainous environment (between 3,900 and 4,500m in this case), and potato varieties allow them to optimally exploit the agro ecosystem and generate new diversity in the process.

Farmers cultivate potato in a three year rotation system, and choose varieties according to the colour of the soil, its temperature, inclination, orientation and exposure. They enrich their seed stock by a number of mechanisms including inheritance, seed fairs, exchanges within families and communities, and reciprocity-based social relations, such as exchanging potatoes for labour. Farmers are always willing try new materials including new high-yielding varieties if they suit their needs.

Besides allowing for an optimum exploitation of the agroecosystem, the use of diversity helps to minimise risks. Ecuador farmer Anibal Correo explains why he plants up to 20 potato varieties in a single plot: "*In a dry year maybe some of the varieties don't yield so much, but then we still have the other potatoes which can put up with some dryness. In a wet year, it can be just the opposite, and we're glad of the potatoes that aren't so liable to rot. There are some varieties which are more resistant to frost, and others are more resistant to cutworms*". Culinary qualities are also very important. Peruvian farmers and consumers are very sensitive to *"subtle yet elaborate"* contrasts in taste, colour and texture. Native potatoes are universally acknowledged to be culinary superior to modern varieties, and landowners may offer them to workers in order to attract them to their fields. In some areas, native potatoes are used as presents. Women play the main role in the identification and selection of varieties, and they are involved in every stage of potato production: seed selection, production, harvest, storage, processing, and cooking.

Sources: G Sentano (1998), *Conservación In Situ de la Biodiversidad de Papas Cultivadas en una Comunidad de la Zona de Puna de la Provincia Tapacarí, Cochabamba,* UMMS, FCAyP, IC/COSUDE and AGRUCO, Cochabamba-Bolivia. Brush, S (1992) "Ethnoecology, biodiversity, and modernization in the Andean potato agriculture" *Journal of Ethnobiology* 12(2): 161-185.

The *Aymara* people invented the freeze-dried potato, which they call *"chuño,"* to enable them to store potatoes year-round. To make *chuño*, potatoes are spread on the ground to freeze overnight. The next day, they are trodden to squeeze out the water. Several days later, the *chuño* is dried and stored.

The preservation of biodiversity in the Andean agricultural systems arises from the cosmovision of Quechuas and Aymaras, which is based in the nurturing of harmony and the mutual support between the three groups that make up the *ayllu*: the community of the *sallqa* (nature), the community of *runas* or *jaques* (humans), and the community of *wacas*, deities (*Seedling* Vol. 15, No. 2, June 1998). Any on-farm conservation effort which does not respect this cosmovision is likely to be at best, short-lived, and at worst, exploitative.

Travels of a potato

Europeans first came in contact with the potato in the Magdalena valley in the Colombian Andes in 1537, and its first recorded use in Europe was at the Sangre hospital in Seville in 1573. Potato was introduced in the US in the early 1700's, probably from Ireland. In Europe, the potato was initially regarded as poisonous or unhealthy, and spread across Europe as an ornamental, through exchanges among botanists. It was not until the Napoleonic wars (1805-1815) that potatoes were accepted as food. The potatoes grown at the time were selections from the original *andigena* types (*Solanum tuberosum* subsp. *andigena)* introduced by the Spaniards, and as such they had a very narrow genetic base.

This shaky foundation caused the first recorded crop failure due to genetic uniformity: the wipe-out in 1845 of virtually all European potatoes by a single infection of late blight, *Phytophthora infestans*. Inadvertently introduced in the US by a biologist returning from Mexico, the fungus had already ravaged potato crops throughout Eastern Canada and the American Mid-West. In Ireland, the effects of the epidemic were catastrophic. England's colonial rule and the concentration of land tenure had left the Irish poor relying on the potato almost exclusively for their food security. The devastation of the crop resulted in the deaths of 2.5 million people, while another million had to migrate to North America. Perhaps less recognised was the concomitant spread of potato blight to Asia, Africa and Brazil. It was only after 1860 that *P. infestans* lost some of its virulence (see *Seedling* Vol. 12, No.3, Oct. 1995), and it remains today's most challenging potato disease (see box).

Potato is a particularly vulnerable crop because it reproduces asexually. It is susceptible to more than 300 pests and diseases, and pathogens in the parent tuber are directly transferred to the harvest and spread to the next generation. Potatoes are prone to viral, fungal and bacterial diseases, predation by insects and nematode infestation. Because of the very narrow genetic base introduced by the Spanish, potato breeding programmes keep turning back to Andean potato germplasm to search for resistance genes, and for sources of cytoplasmic male sterility (for the production of potato hybrids), frost resistance and yield enhancers. A 1989 survey in the US revealed that 11 wild species were present in the pedigrees of 124 varieties released to date, but overall diversity remains dangerously low. The most popular variety in the US, Russet Burbank, developed by Luther Burbank in 1875, accounts for 74% of the fall season varieties US main potato producer state of Idaho (see table on p27). Genetic uniformity is just as extreme in some parts of Europe. In Flanders, Belgium, a single variety developed in 1905, *Binjte*, accounts for 77% of the acreage of the main potato crop.

Yield increases in the most intensive potato growing areas of the US and Europe have been spectacular. According to the UN's Food and Agriculture Organisation (FAO), average potato yields in 1998 in the US, UK and Germany were close to 40 tonnes per hectare, while those of the Netherlands and Canada were just below 30 tonnes per hectare. As a comparison, average yields in Peru and the Russian Federation are slightly below 10 tonnes per hectare. But these yield increases have come at a price: the intensive use of agrochemicals, genetic erosion, environmental damage and farmers' loss of autonomy. Farmers' manoeuvring space has become very tight. As the New York Times reported recently,

"*The economics are daunting : a potato farmer*

FIGHTING *"THE MOST DANGEROUS PLANT DISEASE"*

Late blight continues to be the biggest disease threat to potato growers. After its loss of virulence in the 1860s, late blight was controlled – but not eradicated – by agronomic practices, fungicides, and the use of resistant varieties from Mexico and the Andes. The repeated failure of single-gene resistance approaches to potato breeding left production largely dependent on a single systemic herbicide, Novartis' metalaxyl, in order to control late blight. Blight prevention is very chemical intensive: farmers may spray every 3 to 20 days. If not caught early, the whole potato field is wiped out.

The picture became more complicated when a new population of fungus escaped from Mexico which was even more virulent and resistant to metalaxyl. It also developed sexual reproduction, which allowed it both to increase its genetic diversity and to form oospores which are able to over-winter in soil. The new fungus has spread widely, with Sub-Saharan Africa being the hardest hit.

With late blight being a global problem, it is being fought under a considerable degree of global cooperation. Perhaps the most important collaboration is the Global Initiative on Late Blight (GILB), set up in 1996 by CIP. Most blight research focuses on finding sources of resistance and monitoring the diversity of the pathogen itself. But late-blight resistant varieties are not being cultivated extensively in farmers' fields in the US or Europe. This is partly because farmers can still get by by using heavy applications of metalaxyl, and also because there has been not enough time to introduce the new lines.

Recent research has been seeking polygenic (as opposed to single-gene) resistance to the disease. In 1998, CIP introduced potato varieties suiting the needs of small farmers in tropical countries with long-lasting (polygenic) resistance to late blight. Currently, forty varieties with long-term resistance to the newer version of late blight have been distributed to 16 countries in Africa, Latin America, South East Asia and China. Unfortunately, resistance is only partial, and the new varieties have to be used in conjunction with fungicides and agronomic practices. Genetic engineering approaches to late blight resistance have largely been limited to single gene technologies.

Sources: Various issues of *Diversity*, CIP's website, http://www.cipotato.org/gilb.htm, Horton, D (1987) *Potatoes: Production, Marketing and Programs for Developing Countries*, Westview Press, Boulder (USA), personal communication with US potato breeder Dr. Plaisted, Dr. Juan Landeoof of CIP and Henk Baarveld of NIVAA.

in south-central Idaho [US] will spend roughly $1,965 an acre (mainly on chemicals, electricity, water and seed) to grow a crop that, in a good year, will earn him maybe $1,980. That's how much a french-fry processor will pay for the 20 tons of potatoes a single Idaho acre can yield."

Green Revolution potatoes

The Green Revolution was the US-promoted export of its agricultural model to developing countries, with three main objectives: avoiding hunger-led spread of Communism by

Extent of Major Fall Varieties Planted in 7 Major Potato-Producing US States

	First		Second		Third		Total
State	Variety	%	Variety	%	Variety	%	
Idaho	Russet Burbank	74.4	Ranger Russet	9.1	Russet Norkotah	8.3	**91.8**
Maine	Russet Burbank	26.1	Ontario	17.5	Shepody	15.0	**58.6**
Minnesota	Russet Burbank	49.3	Norland	19.2	Pontiac	5.3	**73.8**
North Dakota	Russet Burbank	42.0	Frito-Lay	15.5	Norland	9.2	**66.7**
Oregon	Russet Burbank	42.9	Russet Norkotah	21.4	Ranger Russet	12.5	**76.8**
Washington	Russet Burbank	41.3	Ranger Russet	17.6	Russet Norkotah	15.4	**74.3**
Wisconsin	Russet Burbank	27.4	Russet Norkotah	20.2	Snowden	13.6	**61.2**

Source: Potato Briefing Room, Economic Research Service, US Dept of Agriculture, http://www.ers.usda.gov/briefing/potato/index.htm

industrialising crop production, integrating developing countries into international markets for US agricultural products, agricultural inputs and technologies, and creating a centrally-controlled system of *ex-situ* conservation of varieties to support the main staple crops. Since its creation in 1971 in Lima, the International Centre for Potato (CIP) has had the mission to implement this agenda for the potato, sweet potato, and other roots and tubers. CIP has also strongly promoted potato cultivation in developing countries in Asia and Africa.

High external input varieties were developed by Peru in the 1950s, and by Colombia and Chile in the 1970s. By the mid-1980s, only in Bolivia was most commercial production still based on landraces, while in Peru more than one half of the commercially-cultivated varieties were high external input. Modernisation has pushed for a new cultivation pattern where most potato surface is monocropped to improved varieties or commercial native varieties. According to CIP, medium-sized Andean farmers owning 5 to 6 hectares plant 80%-90% of their land to improved varieties, 8% to 9% to commercial native varieties, and an important 1% to a diverse potato plot for home use. While most of farmers never buy new seed potato for their traditional varieties, high exernal input potatoes must be purchased every two or three generations, and are thus are only an option for larger farms and wealthier farmers.

Andean farmers have been stricken by the vicious circle of dependency on ever more expensive chemical inputs, indebtedness, falling prices and environmental degradation that have accompanied the introduction of high external input varieties of other crops. Another impact of *"modernisation"* has been the expansion of potato cropping out of the mountains. In Peru, commercially certified seed and irrigation have enabled expansion into coastal areas, where production (10% of Peru's output) is oriented to markets in urban areas. As a result, the potato's rich diversity is quickly being eroded. According to the 1996 FAO report on The State of the World's Plant Genetic Resources for Food and Agriculture, in Peru, 35 of the 90 wild potato species that have been described are no longer found in the wild, due mainly to the destruction of their ecological niches.

The impact of the Green Revolution and agricultural liberalisation for potato in the Andean region is well illustrated by Colombia, a country that has strongly supported formal research on potato through credit, the use of new varieties, new inputs, and public research. Colombia is the main potato producer of the Andean Pact countries. Some 90% of Colombian potato growers are small, peasant farmers owning less than 3 hectares, who grow potato for subsistence and commercial purposes and use traditional varieties yielding about 10 tonnes/hectare. They produce 45% of the national total. Medium-size farmers owning 4 to 7 hectares make up 7% of growers and account for 35% of the potato production, with yields close to 15 tonnes/hectare. Finally, 3% of Colombian farmers have plots larger than 10 hectares, and produce 20% of national potato with extensive use of inputs and yields close to 20 tonnes/hectare. However, the penetration of certified seed in Colombia has been low, with only 1% of it being certified by the mid-1980s, with virtually all seed being farm-saved, exchanged or locally purchased.

Colombia has become an exporter of table potatoes and common seed to Ecuador and Venezuela, and intends to get a larger share of the export market in other Andean countries, within the frame of the Andean Pac free trade area. Producers from Peru, Colombia, Ecuador (and perhaps also Argentina) are increasingly competing for market shares in urban areas, where the fast food industry is growing rapidly. These are served with standardised potatoes grown according to the industrial model and a handful of preferred landraces. The market is not negligible: in one year, Peru imported 19,000 tonnes of pre-cooked and frozen potatoes for the fast-food multinationals. This shift in emphasis in potato production from local markets to urban markets controlled by multinational companies is marginalising small-scale farmers hoping to sell some of their crop. This has serious implications for their livelihoods and the diversity they rely upon.

CIP's good intentions

CIP is aware of the bleak prospects both farmers and potato diversity face. But its solutions are also market-oriented. CIP's three-year long *"Native Potato Seed Repatriation"* programme supplied farmers in a poor region of the Peruvian Andes with 1,200 virus-free traditional varieties. The objective was to introduce both the farmers and their varieties to modern commercial circuits, by generating speciality markets both in Peru (where good *"criollo"* varieties may fetch five times the price of an improved variety) and for export. Albeit well-intentioned, this strategy seems a little short-sighted. Firstly, the number of Peruvian consumers able to pay a premium for quality potatoes is pretty limited. Secondly, there are few examples where supplying export markets has really proved to be a viable option for small farmers, or where their communities have really gained much.

CIP's genebank now holds seed stocks of 1,272 accessions of 140 wild potato species, and about 3,500 accessions of local varieties. Most of these originated in farmers' fields in Latin America. For many years, CIP has tried to develop closer collaboration among potato genebanks around the world. One result has been the establishment of an Inter-Genebank Potato Database, which contained 11,590 wild potato accessions in 1997. CIP policy is to make these materials freely available to all parties. But the trend towards privatising research means that CIP, like many other International Agricultural Research Centres, is in rather an uncomfortable position (see box over page).

One of the main objectives of CIP has been to expand the use of potato as a key contributor to food security in developing countries. Fighting late blight, viruses, bacterial wilt and potato tuber moth are current priorities for CIP. Endemic bacterial wilt, caused by *Ralstonia solanacearum*, causes severe crop losses in tropical, subtropical, and warm temperate regions. Because bacterial wilt cannot be stopped through the use of agrochemicals, CIP's approach focuses on developing early detection kits, screening its genebank materials for resistance, and promoting integrated control approaches to contain its expansion. The main insect pest of potato in the tropics is the potato tuber moth. The moth attacks potatoes both in the fields and in storage, both in the lowlands and the highlands. The current CIP approach is the development of transgenic potato varieties containing a gene from *Bacillus thuringiensis,* developed and patented by Plant Genetic Systems (now owned by Aventis) and the use of a protease inhibitor gene from Axis Genetics.

Another priority of CIP has been to overcome the strong limitation in access to healthy potato seed in developing countries, due to the lack of adequate storage facilities, difficulties in transportation and the difficulty to keep potato seeds virus-free. CIP has rescued a technology that the Aymaras and Quechuas already put in practice in order to renovate their potato stock: True Potato Seed (TPS). The benefits to farmers however, are marginal at best (see box on p30). While the focus of CIP's research programme may be questioned, it has certainly been successful in shifting production back toward the South. India is currently the world's fourth potato producer. Although potato was introduced in India from Europe in the 17th Century, its production has skyrocketed since it has been integrated into input-intensive and irrigated potato-wheat-rice or potato-rice rotating systems in the Indo-Gangetic Plain. As the rest of the components of Green Revolution systems, potatoes are grown primarily for cash. But Indian potato farmers do not always see their investments rewarded: deficient cold storage capacity and the lack of marketing infrastructure often result in depressed prices at harvesting, and in fact potato growing is seen as a high-risk and capital-intensive activity.

Potato is now seen as the third most important food crop in India after rice and wheat. Because of potato growing in India is high-risk and capital-intensive. Established in 1949, the Indian Central Potato Research Institute (CPRI) now has 9 regional research stations and 22 research centres. It's germplasm collection comprises 2,500 accessions, and it has introduced 34 varieties into the country. India is engaged in at least two projects for genetic engineering the potato. Although the processing industry in India is quite limited at the moment, the situation is likely to change in the coming years. India's progress in potato production has certainly benefited from CIP germplasm accessions, breeding lines, TPS, and support, but questions still remain around what those benefits really are. Is the chemical-greedy potato really a blessing or a plague if all the environmental and human costs are factored in?

Enter transgenic potatoes

Potato breeding has traditionally been a long process: it can take up to 25 years to develop a new variety. The main reason for this is that the cosmopolitan species, *Solanum tuberosum*,

FREE ACCESS, FREE-FOR-ALL OR CLOSED SHOP?

CIP abides by the FAO-CGIAR Trust agreements, in which final authority over approximately half a million seed accessions collected prior to the enactment of the Convention on Biological Diversity (CBD) rests with FAO. CIP seems to seek to continuation this free access approach to post-CBD materials. This puts CIP in a potentially tricky position. One example is its current efforts to prospect for potato wild diversity in Peru. The project involves CIP, the Peruvian National Institute of Agrarian Research (INIA), the National Research Support Program-6 (NRSP-6) of the US, the CPRO-DLO in the Netherlands, and the German Potato Genebank of Germany. According to the provisions of the CBD, permission to collect has been requested of INIA. While NRSP-6 and other parties will distribute the materials according to terms of the CBD, the CIP will abide by Material Transfer Agreements (MTAs).

MTAs prevents potential users from claiming any form of intellectual property rights on CIP's accessions and genes. These conditions may limit the ability of commercial breeders from appropriating commercially interesting genes directly, but they are still free to apply for intellectual property rights on any variety they might develop using CIP's materials. This raises the question of whether CIP might be used by the private and public sector in developed countries as a shortcut to access potato diversity without needing to abide by their obligations under the CBD.

For this reason, its engagement with the potato breeding community in the North could potentially raise a conflict of interest for CIP. Unlike some other members of the CGIAR, CIP has been very active in distributing potato materials (including advanced breeding lines) to developing countries. Between 1992 and 1994, NARS in developing countries received 93% of the germplasm samples distributed annually by CIP. CIP is actively cleaning its potato collection of viruses to return accessions to the NARS from the countries of origin. As for advanced lines, recent examples include the distribution of late blight resistant varieties to 16 countries.

CIP's engagement in genetic engineering research is further complicating its access and use policies. It has found itself entangled in an intellectual property quagmire has introduced *"defensive patenting."* Dependency on technologies patented by corporations has already resulted in confidentiality agreements prohibiting it from presenting information in public fora, which is anathema to CIP's self-appointed role as the purveyor of agricultural technologies and knowledge. By accepting patents on transgenic plants and genes, CIP is not only relinquishing its traditional vocation of ensuring the free flow of farmer germplasm and scientific knowledge: it is also sending a strong message to the countries where it is promoting potato production to do the same.

Source: D Spooner *et al* (1999), "Wild potato collecting expedition in Southern Peru in 1998: Taxonomy of New Germplasm Resources." *AJPR* 76: 103-119.

POTATO SEED: TRIED AND TRUE?

Instead of been grown from tubers, potatoes can be grown from True Potato Seed (TPS), produced by the plant's flower. Seeds are grown in seed beds, and later tansplanted into the fields as seedlings or as minitubers. Although this technology needs more labour, in theory it has the potential to dramatically increase the availability of potato seed and decrease its cost. In the words of CIP, *"Farmers who normally plant a hectare of potatoes using two tonnes of seed tubers can achieve the same or better results by planting as few as 100 grams of TPS. Low cost is another TPS benefit: it costs up to $1,200 to plant one hectare of high- tuber seed, while TPS (100 grams) costs only $80 per hectare."* TPS has also the potential, CIP argues, to dramatically increase the speed of introduction of new potato varieties.

Some years after the introduction of TPS into Peru, Indonesia, Egypt and India, the results have not been exactly breathtaking. The yield differences between TPS and tubers were not statistically different, so the new technology only makes economic sense in those areas where access to certified tuber seeds is very limited. The trends towards the liberalisation of the potato seed trade in developing countries may very well increase potato seed imports and thus lower prices, although perhaps at the risk of introducing more diseases. On the other hand, the areas for which TPS have been bred are still very limited, even in India, the leader in TPS use.

Source: CIP Program Report 1997-98. Available from http://www.cipotato.org/market/PgmRprts/pr97-98/pot.htm.

is tetraploid, which means it has four complete sets of chromosomes. This makes for complicated breeding programmes. If genes from wild potatoes are desired, the process is even more complex since wild relatives may have two, four or five sets of chromosomes. Genetic engineering is therefore particularly appealing to potato breeders. They see endless possibilities of using genetic engineering not only as a way to make potato cultivation less dependent on agrochemicals, but also to turn the potato into a bioreactor for industry. Commercial outfits are also drawn to genetic engineering because of the potential to patent and reap royalties from their new varieties.

Some developing countries have developed their own transgenic potatoes. The Central Potato Research Institute of Simla, India, has field-tested its own *Bt* toxin gene, while the Jawaharlal Nerhu University in New Delhi has tested a potato expressing a gene for seed protein containing lysine obtained from seeds of Amaranthus plants (Ama-1 gene). Brazil's EMBRAPA has field-tested Potato Virus Y-resistant potatoes, and South Africa's ARC Vegetable and Ornamental Plant Institute has field tested its own potato leaf roll virus resistance technology.

Potato has also been one of the focuses of the USAID-financed Agricultural Biotechnology Support Project of Michigan State University, which has transferred a Gast-Seed Company-owned *Bt* gene to Egypt's Agricultural Genetic Engineering Research Institute for potato tuber moth control. Egypt is an important potato exporter for Europe, and a good market for the Dutch seed companies. CIP has developed a potato tuber moth-resistant transgenic potato using Plant Genetics System's patented *Bacillus thuringiensis* gene and field tested it in Peru.

Farmers have started to get wind of foreign interests starting to dump genetically-modified potatoes on them and are starting to resist such introductions (see box). Monsanto has also used genetically-engineered potatoes in *"small farmer-oriented"* technology transfer programmes. An example is the ISAAA-brokered collaboration between the Mexican public research centre CINVESTAV in order to develop transgenic virus-resistant varieties for small farmers. Mexico's Biotechnology and Society Research Group reports, however, that small farmers were not consulted. It also suggests that the real problem for small-scale farmers is weakening of the public potato seed distribution system rather than the absence of virus- resistant varieties. While Monsanto is quick to point out that it stands nothing to gain in terms of market share, it hasn't gone unrewarded. One big benefit was that it got to advise the government in drawing up industry-friendly biosafety regulations.

A hot potato for the South

The potato has been an important staple for communities in Andean countries for many centuries. It then became established as a staple in many countries in the North, where it is largely grown according to the industrial model. This model is now being promoted in the South, and the fate of the potato is being grabbed from farmers' hands and placed under corporate control The trend will most probably be strengthened in the future, as agricultural

JUST SAY NO TO GMOs

Introduced from potato growing in temperate areas, cyst nematode infestation is one of the main pests in Andean potato fields, including those of poor farmers. The Bolivian government's Foundation for the Promotion and Research of Andean Products (PROINPA) had set its eyes on a technological fix: the introduction of transgenic resistance to the nematodes into local communities. The technology is owned by the University of Leeds, which intends to provide it free of charge. Bolivian farmers, who were never consulted about the project, became aware of the project in April 2000, when PROINPA applied to Bolivia's National Biosafety Committee for a permit for field trials of nematode-resistant transgenic potatoes of the Dutch variety Desiree.

Bolivian farmers are far from convinced that this transgenic potato is the solution to their problems. Concerns have been expressed about short and longer-term impacts (such as horizontal transfer of the resistance gene into the soil ecosystem, the creation of resistant nematodes and political implications). Containment of the GMO is a particular concern, given the country's role as a centre of origin of the potato. A national meeting of small farmer organisations called for the field release to be turned down, for more attention to be paid to local varieties, and for farmer participation in decisions relating to the introduction of genetically-modified organisms. Under pressure from farmers, AGRUCO, the University of Cochabamba and NGOs, PROIMPA withdrew its trial permit request on June 5, 2000.

Source: Biodiversidad quarterly, June 2000. Available at the GRAIN web site.

markets open and storage options improve. The lowering of phytosanitary barriers to potato seed markets and the increasing trade in processed and pre-processed potatoes will probably increase global potato exchange. Northern fast-food companies are quickly expanding in the South and demand is increasing globally.

Reliance on industrially-cropped potato is a risky business. First, late blight still has tremendous potential to devastate the planet's harvest. Second, in spite of the efforts by CIP to introduce Integral Pesticide Management practices, most potato growing still requires the heavy use of pesticides with damaging effects on farmers' health and on the environment. In addition, there are serious concerns about who will benefit from the potato's expansion. One serious consequence is that small subsistence producers in the Andes who maintain potato's genetic heritage are getting pushed out of the production loop. In addition, the expanded demand for potato in the South is a consequence of increasing urbanisation and the adoption of Northern life styles and dietary shifts. The South's new potato eaters are the well-off rather than the humble. Through its aggressive expansion, the fast food sector may end reaping the largest share of the results of CIP's efforts.

Most current research on the potato is directed towards growing a product to suit the needs of the fast food industry. Those aimed at helping the potato to thrive in new environments in the South are often appropriately motivated, but perhaps misdirected. CIP has a long history of making germplasm available to farmers and institutions in the South, with the aim of producing potatoes tailored to the needs of local farmers. But its strategy for dealing with potato infestations should be questioned. Part of the reason that the potato is so afflicted by disease is that it does not do well in monoculture production. Many of the diseases that CIP is trying to combat are complications of the industrial model of agriculture. The potato moth, for instance, becomes a much more serious problem if the fallow period is removed. Many diseases could be largely combated by promoting diversified farming systems and diversified potato varieties.

The huge investments that CIP and other interested parties are taking in genetic engineering should also be treated with caution. Genetic engineering necessarily undermines biodiversity, which is the long-term key to keeping on top of crop diseases. Public sector institutions cannot enter into genetic engineering research without the support of the private sector. When corporations control the research agenda, they are the ones who will benefit from the fruits of research, not farmers and not consumers.⌘

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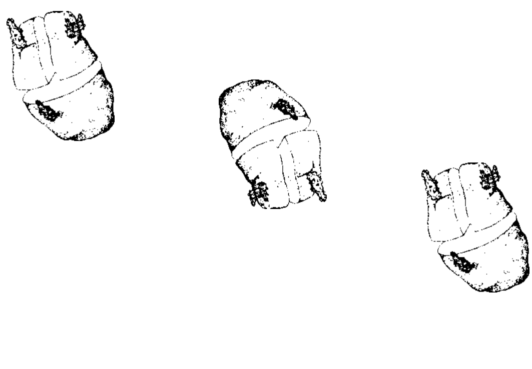


Sprouting Up: THE DIRECTIVE THAT JUST WON'T LIE DOWN

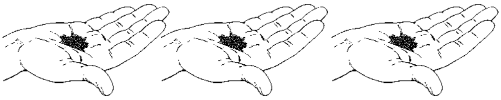
If proponents of the European Union's (EU) *"Life Patents Directive"* had thought that the adoption of the directive in 1998 was the final step in its infamous 10-year saga, they are in for a rude awakening. The directive is back on Europe's political agenda. The deadline for transposition of the directive into national law was July 30th. But many EU governments have become very reluctant to transform the very directive which most of them adopted so enthusiastically at the EU-level only 2 years ago. The stumbling block is the question of patenting human genes.

The deadline for the transposition coincided with the announcement that the whole human genome has now been decoded. In Europe this opened up a public debate on the questions of patentability of these genes. Only weeks prior to the announcement US President Bill Clinton and UK Prime Minister Tony Blair had called for all human genes to remain in the public domain. The disclosure of a patent on human embryos, which had been granted by the European Patent Office (EPO) in 1999, also caused an unprecedented pubic outcry and political stir. Reaction was so extreme that the German government filed a legal opposition to the patent. If the (official) main aim of the directive was to harmonise patent law in Europe, it has failed miserably. The EPO may have incorporated the directive into its own rule-book in anticipation of new national patent laws, but EU governments will only adopt the directive with various amendments, or not at all. The situation has become legally more confusing and incoherent than ever

There seems only one way out of the mess: renegotiate the whole directive at European level – for a third time! Already there are increasingly loud voices calling for such a renegotiation. Several powerful lobby-groups, who kept silent in 1998, have since come out against the directive: most notably perhaps the German Farmer's Association, who recently called for a moratorium on patents on plants and renegotiation of the directive. The government of Germany is reported to have contacted France and the UK to discuss this possibility as well. In addition, on June 30th the Council of Europe in Strasbourg unanimously passed a (non-binding) resolution calling on EU-Member States not to transpose the directive, and instead to pass a moratorium on the patenting of human genes and start renegotiating the directive.

To start the process, the EU-Ministers would need to call on the EU Commission to prepare a new proposal. The Commission, however, has always been a strong supporter of the directive as it stands. But things seem to change there as well: in a recent speech, the European Commissioner responsible for Research, Mr. Busquin, implied a need to act: *"The rule that the product of a discovery should remain within the public domain but that the fruit of invention work can be protected is clear in terms of principle. However, the conditions under which it is applied in the case of 'genomics' need to be clarified in order to avoid any ambiguity or abuse.*"

Source: Thomas Schweiger, who can be contacted at <Tommyschweiger@yahoo.com>



INITIATIVES & ACTIONS

The Long March launched in Thailand.
From September 6-16, farmers organisations in Thailand launched a *"Long March for Biodiversity"* to inform Thailand's farmers and the public about both the negative aspects of genetically-modified (GM) crops and related issues. The campaign aimed to counter industry propaganda which is the only information many Thai farmers have been exposed to in relation to GM crops. Concern over GM crops was exacerbated when two years ago, Monsanto's GM (Bt) cotton escaped from test sites in the country. The government failed to take action. In each province, many activities aimed at building awareness of the importance of local plant varieties were organised and local farmers were given the opportunity to learn more about GM crops and biotechnology. Activists and farmers from neighbouring countries such as India and the Philippines also shared their experiences of GM crops. At each site, ideas and concrete planning proposals were drawn from the local perspective to feed national and international campaigns. More than 2,000 people were involved in the activities.

For more information contact: Mr Witoon Lianchamroon, BIOTHAI, 801/8 Ngamwongwan 27 Soi 5, Muang, Nonthaburi 11000 Thailand. Tel: (66-2) 952 7371 or 952 7953, Fax: (66-2) 952 8312, Email: <biothai@pacific.net.th>

Brazil pushes to remain transgenic-free
Tests undertaken by the Brazils Consumer's Defense Institute (IDEC) and Greenpeace Brasil revealed that foods containing transgenics are being illegally sold in Brazilian supermarkets. In response to consumer pressure, in late July/August the big supermarket chains removed from their shelves those products in which the presence of *t*ransgenic ingredients had been confirmed. Meanwhile, on June 26 and August 9, the Justice in Brazil upheld and earlier decision prohibiting the marketing and production of Monsanto's Roundup Ready transgenic soybeans. Therefore, if not practically, at least legally, Brazil remains a country free from transgenics.

For more information , contact IDEC at http://www.uol.com.br/idec or email: <ceipe@zaz.com.br>

Five Year Freeze launched in South Africa
The South African Freeze Alliance on Genetic Engineering (SAFeAGE) has launched a campaign calling on the government of South Africa to introduce a minimum five-year freeze on: 1) the growing of GE crops for field trials or commercial purposes until the technology is proven to be safe, environmentally harmless, and in the interests of the people of South Africa and her neighbours; 2) the import and export of GE foods and farm crops; and 3) the patenting of genetic resources for food and farm crops. SAFeAGE is a coalition of organisations who support the 5-yr Freeze Manifesto. Individuals and groups are being asked to write letters to government ministers and the media, and to encourage local suppliers to stock and label GM-free foods.

For more information, contact: Karen Kallmann at SAFeAGE. Tel: (27-21) 761 0549, Email: <safeage@mweb.co.za>

Strengthening North-South solidarity
The GANAS network (formerly the South-South/South-North Exchange: Alternatives to Globalization) is looking for new members.

GANAS seeks to strengthen solidarity among struggles in the global South and North to fight corporate globalization and to construct environmentally and economically just alternatives. GANAS builds *"globalization from below"* by bringing together social movements, especially of low-income people and peoples of different ethnic backgrounds, to exchange analysis and experiences, develop regional advocacy strategies, and create collective strength across borders. Some of its activities include: hosting bilateral exchanges between counterpart movements in different countries; strengthening regional advocacy strategies; sponsoring international speaking tours by representatives of grassroots struggles; connecting people from the global South with resources in the US, including technical support and fundraising assistance; and disseminating information about alternatives to globalisation.

For more information, contact: GANAS — Globalization Alternatives North and South, 1830 Connecticut Ave, NW, Washington, DC 20009, USA. Tel: (1-202) 232 1999 Fax: (1-202) 328 0627 Web: http://www.econjustice.net/ganas.htm Email: <ganas@post.com>

New US campaign against GM foods

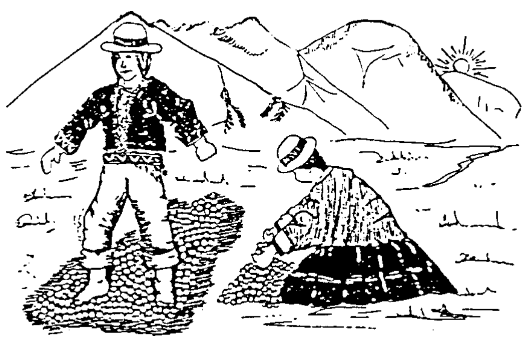
A coalition of seven national consumer and environmental groups have started a campaign to keep genetically-engineered ingredients off US grocery store shelves, unless they are thoroughly safety tested and labelled. In its first expose, the coalition known as Genetically Engineered Food Alert (GEFoodAlert) announced that GM corn not allowed in food because of concerns it could trigger allergies had been detected in grocery store Taco Bell taco shells. The Bt corn used in the shells, which was produced by Aventis and called StarLink, was approved by federal authorities in 1998 as animal feed. But because Starlink contains the Cry9C protein, which makes the corn more difficult to break down in the human gut, it was not approved for human use. The campaign was launched in 21 cities across the US, with activists demonstrating outside supermarkets. Kraft, owner of Taco Bell, eventuall withdrew all corn shells from stores and fast food outlets. GEFoodAlert was created by Center for Food Safety, Friends of the Earth, Institute for Agriculture and Trade Policy, National Environmental Trust, Organic Consumers Association, Pesticide Action Network, and the State Public Interest Research Groups.

For more information, contact the Institute of Agriculture and Trade Policy (IATP) at 2105 First Avenue South, Minneapolis, MN 55404 USA. Tel: (612) 870-0453. Email: <iatp@iatp.org> Or visit GEFoodAlert's website: http://www.gefoodalert.org

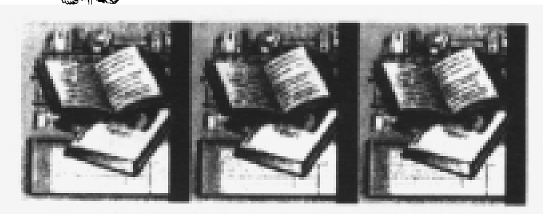
ActionAid joins basmati campaign

ActionAid is campaigning in support of India's demand for the World Trade Organisation (WTO) to protect basmati rice from biopiracy. The Indian government has filed a legal challenge against a patent held on basmati by US-based corporation RiceTec Inc and is urging the WTO to extend rules which safeguard products from specific regions like champagne and scotch whisky. ActionAid is also backing African-led calls at the meeting for the WTO to ban patents on plants.

Contact ActionAid - in the UK Tel: (44-20) 7561 7614, Fax: (44-20) 7281 0999 Email: <PCollins@actionaid.org.uk> or ActionAid in India, Tel: (91-80) 227 1443, Fax: (91-80) 227 3933



Making "chuño" - Andean freeze-dried potatoes



RESOURCES & DOCUMENTATION

Indigenous Peoples of Colombia and the Law: A critical approach to the study of past and present situations, takes a historical and sociological look at the relationship between indigenous peoples and the successive legal frameworks established in their territories since the Spanish occupation more than 500 years ago. In the land currently under Colombian sovereignty lived many peoples, among them the Tayrona, Muisca, and Zenú. Their cultural resistance has led to the adoption by Colombia of national and international obligations, including the recognition of individual and collective rights under the State Constitution of 1991. The author deals with the current problems faced by Colombia's original peoples, such as civil war, drug trafficking and internal organisational processes. The book has a final chapter with a comparative analysis of the situation of indigenous populations in several Latin American countries.

Roque Roldán Ortega, *Indigenous Peoples of Colombia and the Law: A critical approach to the study of past and present situations*, GAIA Foundation/ ILO/COAMA, Bogota, 192 pages, ISBN 958-96633-4-6. Also available in Spanish. For copies please contact: The Gaia Foundation, 18 Well Walk, Hampstead, London NW3 1LD, UK. Tel : (44-171) 435 50 00. Fax : (44-171) 431 05 51. Email: <gaiafund@gn.apc.org>

Cultural and Spiritual Values of Biodiversity is a massive and useful work edited by anthropologist Darrell Posey. As noted in one of the introductory texts, two recent consensus among the Western scientific community have led to wider acceptance of the role of indigenous peoples and local community based knowledge in the management of biodiversity: that humans form an integral part of biological diversity; and that the most important area of interaction with that diversity is agriculture and other nature-based livelihood procurement activities. Chapters deal with the link between nature, society and culture; language diversity and rights; spiritual values as central to indigenous peoples knowledge systems; cultural and biological diversity erosion; traditional ecological knowledge and sustainability, medicine, and agriculture; and rights to land territories. The book concludes with a call for recognition that the future of biodiversity also rests on respect on the myriad of views, values and visions that form the mosaic of life.

Darrell Posey, *Cultural and Spiritual Values of Biodiversity,* UNEP/IT Publications, Nairobi/London, 1999, 731 pages, ISBN 1-85339-394-0 (paperback). For orders contact: IT Publications, 103/105 Southampton Row, London WC1B, UK. Fax: (44-171) 436 2013. Email: <katerinas@tipubs.org.uk >

Intellectual Property Rights, Trade and Biodiversity scopes the history and current discussion on patents and other types of intellectual property over plant genetic resources and traditional knowledge in a North-South perspective. The author, who is known for his work with the Traditional Resource Rights Working Group at Oxford, does a good job of zeroing in on some of the main points that are being wrestled with today. Case studies of specific approaches and experiences are provided, as well as offering recommendations for further study and action. The book argues that we need to find a *modus vivendi* between indigenous peoples' own intellectual property rights systems and conventional *("Western")* non-patent IPRs.

> **Graham Dutfield, *Intellectual Property Rights, Trade and Biodiversity: Seeds and Plant Varieties,* IUCN/Earthscan, 2000, 231 pp, ISBN 1-85383-692-3. To order, contact Earthscan Publications, 120 Pentonville Rd, London N1 9JN, UK. Fax: (44-171) 278 11 42. Email: <earthinfo@earthscan.co.uk> Web: http://www.earthscan.co.uk**

Farmers' Seed Production covers a whole range of issues relating to local seed supply systems, including participatory plant breeding, and both technical and practical information on seed production and variety maintenance. Authors suggest new approaches and methods to support on-farm seed production by small-scale farmers in developing countries. Discussions about local seed systems, their strengths, limitations and possibilities for improvement are included, among other issues as genetic diversity, in situ conservation, gender and legislation. It also gives technical information on seed production, selection, storage and distribution and other questions related to varietal maintenance and improvement of the most important food crops. The last part of the book contains crop-specific information relevant for improving seed production of the most important agricultural and horticultural crops.

> **Conny Almkinders and Niels Louwaars, *Farmers' Seed Production: new approaches and practices,* Intermediate Technology Publications Ltd, London, 1999, 291 pp, ISBN 1-85339-466-1. Order from: IT Publications, 103-105 Southampton Row, London WC1B 4HH, UK, Fax: (44 171) 436 20 13; Email: <orders@itpubs.org.uk> Web: http://www.oneworld.org/itdg/, Priced at £14.95 or $29.95.**

Presented as *"People, Plants and Patents Revisited,"* reflects the discussions of various constituencies involved with the use and conservation genetic resources from different perspectives, including civil society, academia and industry. A non-consensus report, *Seedling Solutions* provides an updated framework on the struggle on the property on and access to genetic resources, including the privatisation of knowledge, the erosion of genetic an cultural diversity, the commercialisation of transgenic crops, the increasing economic importance of human biodiversity, and progress in molecular bioscience. The book attempts to avoid treating the issues as the result of a constellation of international and national legislation and provide political analysis instead. The most striking difference between this book and its predecessor *People, Plants and Patents* is the extension of the debate to include human genetic resources.

> **The Crucible II Group, *Seedling Solutions. Volume 1. Policy Options for genetic resources: People, Plants and Patents Revisited,* International Development Research Centre, International Plant Genetic Resources Institute, Dag Hammarskjöld Foundation, Rome, 2000, 121 pp, ISBN 0-88936-926-7. Available from International Plant Genetic Resources Institute (IPGRI), Via delle Sette Chiese, 142, 00145 Rome, Italy. Web: http://www.cgiar.org/ipgri**

On 26 July 1999, 28 Greenpeace volunteers were arrested for their part in peacefully removing a crop of genetically modified corn. *GM on Trial* brings together the statements submitted to the court by scientific experts, demonstrating that they had a *"lawful excuse"* to remove the corn since their beliefs about the risks of GM contamination were reasonable. The book compiles the testimonies of experts on different aspects of GM safety, each of which put together the most recent evidence to support their case, so that *GM on Trial* contains a good deal of referenced information that may be of use to campaigners against GM releases. The issues covered include wind pollination, bee pollination, risks to organic farming, the weakness of the concept of substantial equivalence, hazards to food and animal feed, horizontal gene transfer, impacts on the soil, implications for pesticide use, farm scale trials and environmental safety. One limitation is that the treatment of the issues is very much conditioned by the GM debate in the UK.

Michelle Allsopp and Doug Parr (Editors), *GM On Trial*. Greenpeace, London, 2000, 92 pp. Available from Greenpeace, 1 Canonbury Villas, London N12PN, UK. Tel: (44-207) 354 5100. Fax: (44-20) 7696 0014. Web: http://www.greenpeace.org.uk

UK-based The Food Commission and GeneWatch have co-published *Biotech – The Next Generation: good for whose health?*, a timely critical look into the state of the art in the so-called *"second generation"* genetically-engineered crops, which are to be used in so-called *"functional foods"* or *"nutraceuticals."* The report first puts second generation transgenic crops in the wider context of functional foods, and then looks in detail at the main areas in which research and development has been focused: the increase of the content of vitamins, minerals and other micronutrients, fats and oils, and other food modifications. For each of these, the authors look at what is in the pipeline, main developers, benefits to agro-food industry versus benefits to the consumer, and alternatives.

Sue Dibb and Sue Mayer, *Biotech – The Next Generation: good for whose health?*, The Food Commission/GeneWatch UK, London, 2000, 54 pp. Priced at £10. Orders: The Food Commission, 94 White Lion St, London N1 9PF, UK. Fax: (44-20) 7837 1141.

Outreach is a biodiversity pack devoted to educators and communicators. The explanation of the biodiversity issue includes a backgrounder on the basic scientific concepts that need to be understood in order to understand the conservation of genetic diversity in food plants as well as practical examples and proposals for activities.

Gillian Dorfman *et al* (eds), *Outreach: Information for Educators and Communicators,* Biodiversity Series, Issue pack: *Genetic Diversity and Food Crops*, 130 pp., Solution pack: *Preserving Genetic Diversity of Crop Plants*, 38 pp, Solution pack: *Breeding Your Own Crops*, 40 pp. Available from: TVE USA-Outreach, PO Box 820, Shelburne, Vermont 05482, USA. Tel: (1-802) 985 14 92, Fax: (1-802) 985 20 11, Email: <tve-dist@tve.org.uk> Web: www.oneworld.org/tve info.tve.org

GENES ON THE INTERNET

Set up by an international consultant specialising in potatoes, and sponsored by Zeneca, Global Potato News web intends to be *the* web page and internet gateway for the potato industry. As such, it is very useful for people monitoring it. The web page claims to have 1,400 hyperlinks to other pages. Particularly interesting is the *"Articles"* section.

http://www.potatonews.com/

The web site of the World Potato Congress counts with the regular contributions of an expert on potato growing systems in South East Asia and the International Centre for the Potato (CIP). It also publishes a monthly article that may cover the situation of potato breeding and industry in a given country, such as Argentina, Uruguay or Morocco, or the state of the art in an issue. Good links.

http://www.potatocongress.org

The India-based International Collective in Support of Fishworkers, an international NGO working on issues that concern fishworkers the world over, has launched a new website. Although it is obviously under construction, the website contains the last issues of its *Samudra Report* on-line. *Samudra* focuses on the issues of access to fisheries, the effects of

industrialisation and the export of fishing overcapacity from North to South, the struggle of fishing communities from India to Canada, international trade and international negotiations dealing with fisheries. Unfortunately, for the moment only PDF archives of whole *Samudra* issues are available, and articles cannot be downloaded individually.
http://www.icsf.net

In an internet dominated by the English language, the website of *Cahiers Agricultures* intends to fulfil a space for Francophone countries. A prestigious peer-reviewed publication on agriculture, it includes many topics, including genetics, biotechnology, the environment, agricultural policies, and the rural economy. Articles are wholly accessible through thematic and author indexes.
http://aupelf-uref.org/revues/agri/

Primal Seeds' website is a breath of fresh air. Here the political issues surrounding genetic erosion and the corporate takeover of the food supply are linked to direct experience. It offers an invitation to visitors not only to reflect, but also to take action to contribute to the creation of local food systems based on biodiversity. A website to enjoy.
http://www.primalseeds.org/

SEEDLING

is the quarterly newsletter of Genetic Resources Action International (GRAIN), an international non-governmental organisation (NGO) based in Spain. GRAIN promotes the sustainable management and use of agricultural biodiversity based on people's control over genetic resources and local knowledge, with a special emphasis on developing countries. *Seedling* aims to provide a platform for the exchange of news and analysis among people engaged in these issues. We need your input. Please send us information about your activities: articles, campaign materials, research results, criticism and suggestions.

SEEDLING

is published and edited as a collective effort of GRAIN staff. Janet Bell acts as managing editor. GRAIN staff currently comprise: Nelson Alvarez, Amèlia Foraster, Noemi Gaddi, Daniela Gimeno, Henk Hobbelink, Anna-Rosa Martínez, Raquel Núñez, Lene Santos, Aitor Urkiola and Renée Vellvé. Outside contributions are indicated in the by-line and should be attributed to their respective author(s). *Seedling* materials may be reproduced and disseminated freely. We ask only that the original source be acknowledged and that a copy of your reprint be sent to the GRAIN office.

SEEDLING

is available free of charge to groups and individuals in the South, as well as to the NGO community at large, upon request. Institutions and others in industrialised countries are charged a subscription of US$35 per year, payable by cheque in US$ to GRAIN. Seedling is also available on-line at GRAIN's web site (see below). Please direct all correspondence to:

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