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BATTLE ROYALE OF THE 21ST CENTURY

KRISTIN DAWKINS

Two key intergovernmental meetings at the turn of the millennium have raised hopes that the seemingly unstoppable train of globalisation may actually be forced to slow down after all. The US and its globalisation disciples were thwarted in their efforts to get the World Trade Organisation to take on biotechnology issues in Seattle and in their attempts to handcuff developing countries into adopting the unrestricted trafficking of genetically modified products at the biosafety negotiations in Montreal. As a result, governments, industry, NGOs, farmers and civil society groups are now positioning themselves for a major showdown over the role of biotechnology in agriculture.

Back in 1997, US Secretary of Agriculture Dan Glickman described biotechnology and the patenting of life as *"the Battle Royale of 21st century agriculture."* In Seattle during the closing month of the 20th century, the United States and its cohort of fellow exporters of genetically modified organisms (GMOs) fired their first shots in this battle and found that they fizzled. Not only did the World Trade Organisation (WTO) fail to launch a new round of trade talks, but proposals for the WTO to consider biotechnology issues also flopped.

In the first month of the new century, the US and other GMO exporters lost another round – their eight-year campaign to avoid a new international treaty to help safeguard the environment and public health related to the GMO trade. The *"Cartagena Protocol on Biosafety,"* agreed in Montreal in January, establishes an international regulatory regime based on the precautionary principle to manage the unique risks of GMOs. These two events have put the brakes on the globalisation bandwagon, at least for a while, and offer hope to governments and civil society organisations pushing for a saner approach to the management of biotechnology and a more sustainable approach to agriculture.

Seattle's spectacular failure

In Seattle, the biotech lobby was seriously let down. The US joined Canada and Japan in proposing a WTO *"Working Party on Biotechnology"* whose mandate was unclear. The US wanted it *"to examine approval processes"* for GMOs – taking dead aim at the European Union's (EU) array of national and regional restrictions on the import, planting and consumption of genetically engineered seeds and foods. A large number of developing countries objected, however, largely on grounds that the proper place to debate the matter was at the biosafety negotiations a month later, not at the WTO – and they never gave in.

As the obvious target of the WTO proposal, the EU was initially in agreement that biotechnology should be dealt with through the biosafety negotiations. EU delegates therefore reacted with outrage when the lead negotiator for the EU, Commissioner Pascal Lamy voiced EU support for a Working Party. Lamy defended his position by saying, *"My job as a negotiator is how to get the maximum… I have to spend money to get money. I don't find it a problem if I can get what I need… At the end of the day, the Council [of Ministers] will make their decision."*

With the collapse of the Seattle meeting, the biotech issue is probably moot at the WTO, at least for the time being. But in Brussels there is surely a fierce debate raging over the democratic rights and responsibilities of the European Commission. For Europeans, the issues of democracy and food safety mingle in a profound way. Last year, the WTO overturned their ban on imports of beef laced with growth hormones, agreeing with the US that the ban is not *"scientifically justifiable"* and acts as a *"barrier to trade."* EU attempts to include the precautionary principle as a justifiable consideration in WTO policies were rebuffed by the US and its friends.

Patents on Life

Several key proposals from developing countries were severely watered down during the Seattle negotiations. One of the most important of these was text developing countries, led by the African Group, had drafted amending the Uruguay Round Agreement on Trade-Related Aspects of Intellectual Property (TRIPs). The text proposed modifications so that *"All living organisms and their parts cannot be patented; and those natural processes that produce living organisms should not be patentable."* The list of exceptions to patentability would include the list of essential drugs identified by the World Health Organisation. In addition, they called for revisions to *"ensure the protection of innovations of indigenous and local farming communities; the continuation of traditional farming processes including the right to use, exchange and save seeds, and promote food security."*

In the last draft to emerge in Seattle, however, WTO members merely pledged to *"examine, in cooperation with other relevant intergovernmental organisations, the scope for protection…relating to traditional knowledge and folklore…and other legal means and practices, both national and international."* While this draft is now scrapped, along with the rest of the Seattle compromises, on-going reviews of the TRIPs Agreement are part of the WTO's *"built-in"* agenda, so developing countries will at least have a chance to pursue their proposals for reforms in the future.

Down to Earth, Centre for Science and Environment

Taking on the bullies

The lack of democracy in Seattle was one of the main reasons for the failure to launch a new round of WTO trade talks. Developing countries complained of a systematic failure to implement those elements of the Uruguay Round agreements that benefited them, while those benefiting the industrialised sector have been rigorously enforced. In the months preceding Seattle, the Like-Minded Group staked out negotiating positions to remedy these matters. At the meeting, however, the US and EU gave short shrift to these proposals, committing themselves merely to *"examine with particular care"* or *"take note of concerns"* in response, or to make *"more operational"* or *"more transparent"* those matters already agreed.

Fingers were also pointed at US Trade Representative Charlene Barshefsky and WTO Director-General Michael Moore for Seattle's failure, who resorted to the infamous *"Green Room"* technique, inviting selected governments into a closed-door session designed to brow-beat them into a series of trade-offs on the most contentious issues. While a common technique in past trade negotiations, it backfired in Seattle. As a group of Caribbean countries put it, *"as long as due respect to the procedures and conditions of transparency, openness and participation that allow for adequately balanced results in respect of the interests of all members do not exist, we will not join the consensus to meet the objectives of this Ministerial Conference."* This sentiment was echoed by African and Latin American countries as well, foreshadowing by one full day the eventual announcement of December 3rd that the Seattle talks were ended.

There is no doubt that the fifty thousand or more citizens who dominated the streetscape of Seattle and the news reports worldwide also had an impact on the results. Trade unionists, religious and peace activists, consumer and environmental advocates, and thousands of young people fed up with corporate globalisation and the dictatorial behaviour of the WTO made it clear that *"business as usual"* was unacceptable. Some of them were back a month later, this time to lobby their governments at the biosafety protocol meeting in Montreal. Hundreds of citizens also poured into the streets in frigid windy weather to march and hold overnight vigils and otherwise demonstrate their objections to Canadian complicity in the US-led attempts to sabotage the meeting. Again, these groups can take some of the credit for the qualified success of the Montreal meeting.

A biosafety protocol at last

The Cartagena Protocol on Biosafety establishes an international regulatory regime based on the precautionary principle to manage the unique risks of GMOs. All national governments' rights to regulate all GMOs are affirmed, while developing countries and countries in transition (the former Soviet states) may use the Protocol to regulate commodities even before national policies are in place. The protocol will become enforceable once 50 nations ratify it through their domestic legislative processes. Legally, the United States cannot become a party to the new Protocol until it ratifies the parent treaty, the Convention on Biological Diversity (CBD). But the rest of the world made sure that it will have to follow the rules: the new law says that GMO trade between parties and non-parties *"shall be consistent"* with the Protocol's objectives and that parties *"shall encourage"* non-parties to comply.

In addition to environmental impacts, human health and socio-economic factors are recognised as valid considerations in determining whether to accept or reject GMO imports. A permanent centralised information centre called *"the biosafety clearinghouse"* will

be set up on the Internet, and work will continue to further develop the terms of the Protocol. Within two years, details on the documentation required to accompany shipments of GMO commodities must be worked out: at present, they need only warn that they *"may contain"* genetically engineered grains.

At the same time many at Montreal felt that too much was given up to appease the US and the Miami Group. For example, one big loophole in the new treaty, affects commodities – that is, GMOs *"intended for direct use as food or feed, or for processing."* Commodities are not subject to the full *"Advanced Informed Agreement"* procedure, whereby an importing country's government is notified of each impending shipment and then has the option to accept it or not. Instead, notification of a new approved GMO in one country is posted at the biosafety clearinghouse. Each potential importing government has the burden of monitoring the site for all new GMOs all the time, whether or not they are on their way to that country, or whether or not the importing country has the resources to set up complex electronic Internet monitoring systems. They can, however, still inform the exporting country that they will not accept any shipments of that GMO, based on the precautionary principle, as long as risk assessment procedures have been followed.

While this is a significant loophole, it is important to remember that the US and its five allies – Canada, Australia, Argentina, Uruguay and Chile – deadlocked what was supposed to be the final negotiation in Colombia in February 1999 over the issue of commodities. Calling themselves the *"Miami Group,"* these six grain exporters demanded that commodities be altogether outside of the Protocol's scope on grounds that their regulation would be a barrier to trade. The rest of the world argued that genetically-engineered commodities carry the same biological risk as GMOs intended for direct release into the environment, like seed, and therefore must be just as carefully managed. As the Ethiopian spokesperson Tewolde Egziabher explained for what became known as the *"Like-Minded Group"* of some 100 or more countries, a bag of feed corn is just as likely to spill off a truck during transit as a bag of seed corn, and farmers with a field to sow are unlikely to notice whether a bag of corn is labeled *"seed"* or *"feed."*

So polarised was the debate that Chairman Juan Mayr, Colombia's Minister of the Environment, called a special *"informal"* meeting in Vienna some months later to try to work through the most intransigent issues. Perhaps this process helped: virtually all observers agree that Chairman Mayr's diplomatic skill and commitment to achieving a protocol were instrumental in breaking through the deadlock. Another factor could be an increase in consumer and environmental concern in the Miami Group countries, including a series of high-profile lawsuits filed against the US Food and Drug Administration, the US Environmental Protection Agency, and the Monsanto Company and the other so-called life-science conglomerates. It is also likely that the WTO's debacle in Seattle had its effect. Whatever the factors, the Cartagena Protocol on Biosafety finally establishes – although still quite short of many peoples' hopes and expectations - a global framework for GMO regulation.

Caution prevails

In the lead-up to Montreal, the EU insisted that the precautionary principle was a non-negotiable demand. Its steadfastness paid off. The Cartagena Protocol articulates what may be the most advanced expression of the precautionary principle in any international agreement. It states that, *"lack of scientific certainty due to insufficient relevant scientific information and knowledge regarding the extent*

of the potential adverse effects…shall not prevent [a] party from taking a decision, as appropriate, with regard to the import" of a GMO.

Genetic engineering is still a young science, and it is widely agreed that proof of harm and proof of safety are as yet lacking. Given the risk of a potentially catastrophic scenario such as the annihilation of honey bees due to the spread of Bt toxins, the precautionary principle could be seen as necessary protection for governments to enable them to restrict GMO imports should they be challenged at the WTO by zealous exporters. However, the compromise struck in Montreal is so delicate, lawyers may never be able to sort out which treaty should prevail. In exchange for the precautionary principle, the EU conceded a weird recitation of clauses in the preamble of the Protocol regarding its relationship to the WTO. These read:

- *"Recognising that trade and environment agreements should be mutually supportive with a view to achieving sustainable development,*
- *"Emphasising that this Protocol shall not be interpreted as implying a change in the rights and obligations of a Party under any existing international agreements,*
- *"Understanding that the above recital is not intended to subordinate this Protocol to other international agreements…"*

While these phrases may seem internally contradictory, they could also give lawyers at the WTO an excuse to ignore the Protocol altogether. However, a further subtlety that was key to the compromise was the EU's insistence that the placement of the precautionary principle and the so-called *"relationship issue"* be switched: in earlier drafts, references to a *"precautionary approach"* appeared in the preamble, which is not considered legally-binding, while the relationship clauses used to be in the legally-binding operational text.

The trade:environment conundrum

At the heart of these legalistic shenanigans is a longstanding ambiguity in international law: the relationship between a multilateral environmental agreement (MEA) and a trade agreement with inherently contradictory purposes and terms. The WTO's Committee on Trade and Environment has grappled with the problem unsuccessfully since 1994. The Cartagena Protocol carves out new legal and institutional ground in the international policy framework, though only time will tell to what extent it will help in establishing MEA predominance on environmental matters. As yet, no dispute has as yet been filed at the WTO staking terms of an MEA against terms of the WTO. But many suspect that the US has had plans to challenge the EU's array of GMO regulations as soon as the Biosafety Protocol was agreed (assuming the Miami Group were successful in lobbying for it to be subordinate to or, at a minimum, equal to the WTO). Whether the ambiguous language in the Protocol will enable the WTO to ignore the Protocol's terms may soon be known. In the glare of recent publicity, private interests may decide that the WTO is no longer the right place to seek to expand corporate rights over human rights.

Indeed, less familiar settings for international deal-making have already put the issue of GMOs on their agendas. For example, the Codex Alimentarius Commission – a body of the UN's Food and Agriculture Organisation and the World Health Organisation that once set guidelines for food safety regulations but was annointed by the WTO as the presumptive standard-setting body – has set up a "*Committee on Bio-engineered Food."* And the Trans-Atlantic Economic Partnership is set up to devise executive level *"Mutual Recognition Agreements"* to harmonise US and EU regulations, bypassing the normal regulatory processes of each country. How these

international agreements would relate to the Protocol, the WTO and each other adds greater dimensions of complexity to the contemporary challenge of multilateral governance and achieving global democracy.

Great minds think – and act – alike

In Montreal, the Like-Minded Group – representing well over 80% of the planet's population and at least 80% of its biological diversity – was steadfast in its commitment to biosafety. They insisted that all GMOs can have potentially harmful interactions within a given specific ecosystem, and that there is no substitute for case-by-case risk assessment and no substitute for nationally-determined risk management. They also insisted that the scope of the Protocol be comprehensive, and it is – despite a number of loopholes. They were especially adamant about commodities, and despite the Miami Group's most vigorous objections, commodities are included. Thanks to their unwavering unity as a negotiating bloc, the mostly developing country members of the Like-Minded Group were largely successful in achieving their aims.

In the last hour of the Montreal meeting, the government of France offered to host the first intergovernmental meeting to prepare for the entry into force of the *Protocol "before the end of 2000."* France having some of the strongest regulations against GMOs, and French farmers being among the most militant in the world, it should be an interesting meeting! Already, citizens are mobilising to go to Paris and support the call for ever more effective regulations of GMOs at all levels of government.

Next stop Paris?

There is considerable uncertainty about what happens next – but also a renewed spirit of public optimism. As history unfolds, the spectacular failure in Seattle may have a galvanising effect on the developing world's leadership as well as on civil society worldwide. There is a growing sense that not only the WTO but all of the entrenched bureaucracy of corporate globalisation is vulnerable to citizen action. And it seems altogether probable that the Seattle and Montreal events will have a dampening effect on US enthusiasm for a WTO dispute over GMOs. If the dispute settlement body were to agree with the US that European regulations on GMOs are illegal, the public's reaction could be fierce enough to seriously damage the WTO's credibility.

In Geneva, negotiators are back at the drawing table working on agriculture issues. One of the objectives of the Uruguay Round was *"fundamental reform"* of agricultural issues, taking into account experience to date and *"non-trade concerns*" such as the environment and food security. There is no mandate for the WTO to consider biotechnology, although there may be more momentum than before to settle the perennial question of the WTO:MEA relationship. The required review of the TRIPs Agreement should also go forward. Support for the African and Like-Minded Groups' proposals could help ensure economic and political justice as well as recognition of the social and cultural rights of rural communities over genetic resources.

In follow-up to the Cartagena Protocol, it is already time to plan for the meeting in France that will take place this year. Farm organisations, environmentalists, consumer groups, and others should begin preparations for this event. Research into the liability and labeling issues must go forward, in the international as well as national contexts, to ensure that each country's delegations have a clear mandate in advance.

The Conference of the Parties to the Convention on Biological Diversity will meet in Nairobi in

May 2000, to review progress towards not only the Cartagena Protocol (which will open for signature there) but also towards implementation of the obligation to *"respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities*" and more generally promote the sustainable conservation and use of biological resources and the equitable sharing of their benefits. Similarly, the UN's Food and Agriculture Organisation will continue its efforts to reach agreement on an international treaty regarding the management of genetic resources for food and agriculture later this year, a treaty that could become yet another protocol to implement the 1992 Convention on Biological Diversity.

Citizens in many countries are becoming more aware, more alarmed and more organised in their objections to GMOs. Supermarkets and other buyers in the commercial chain from producer to consumer are declaring themselves GMO-free or offering premiums for GMO-free products. More and more farmers are opting to plant non-GMO seeds in the North, while in the South farmer organisations openly reject transgenic crops as an option for increased food security and sustainable development. Many national regulatory agencies in the South and North are preparing more rigorous procedures for evaluating GMO safety.

In the United States, which as usual has acted as an outlaw in the world community of nations, there is dramatic and rapidly growing support for positive action regarding genetic engineering and the protection of genetic resources (see *Sprouting Up* on p 31), which may lead to changes in US policy in the near term. Meanwhile Europe is becoming more frigid to biotech's touch. Last July a highly-respected Deutsche Banc's report entitled *"Ag Biotech: Thanks But No Thanks!"* warned investors that *"European concerns are very real and not merely a trade barrier."* In October, the European Commission proposed making permanent a moratorium in effect since 1990 against the use of genetically altered bovine growth hormone. Meanwhile, Japan, Korea, Australia, and New Zealand have joined the EU in demanding labels on GMOs. It may be that having failed to deflect the labelling issue, the biotech industry itself may opt for a co-ordinated international system rather than trying to find its way through a maze of varied national regulations.

All told, biotech is *"the biggest issue in agriculture today*" – as a spokesperson for the US delegation said in a briefing with non-governmental organisations in Seattle – and agriculture has certainly been the most troublesome issue facing the WTO negotiators since the beginning of the Uruguay Round in 1986. The Cartagena Protocol on Biosafety will help resolve this thorniest of agricultural problems. ⌘

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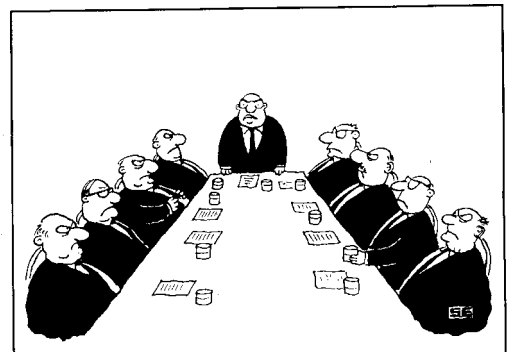
For more information on both Seattle and Montreal , see 'Genes on the Web' on p 39.



Stan Eales, The Ecologist

ENGINEERING SOLUTIONS TO MALNUTRITION

GRAIN

Some 40% of the world's people suffer from micronutrient deficiencies. The 'solution' to this problem is now being promised through genetic engineering. In the face of growing resistance to the first generation of genetically modified foodstuffs, Vitamin A or 'golden' rice provides a golden opportunity to restore biotechnology to public acceptability. Not only will it address a global public health problem, but it is being promised free to farmers. Monsanto has also been developing high beta-carotene mustard which it is targeting – for free – to poor farmers in the South. These nutrient-enhanced crops are receiving a good deal of attention, particularly in delivering the promise of genetic engineering in the guise of humanitarian cause. Too good to be true? Technical fixes such as these will only treat the symptoms of micronutrient deficiency and propagate the problem, which is caused by declining diversity in the food being produced and consumed.

Despite improvements in global food supplies, malnutrition and hunger remains one of the most devastating problems facing society. Malnutrition caused by deficiencies in specific vitamins and minerals afflict some 40% of the world's population, especially women and children. Ironically, the largest numbers of people suffering from micronutrient malnutrition live in South Asia, where a high diversity of micronutrient sources, such as fruits and vegetables, exist.

Vitamin A deficiency (VAD) is one of the leading causes of micronutrient malnutrition in developing countries. Historically, vitamin A was recognised to be important for the prevention of blindness. More recently, its role in helping to fight infections has come to light. Vitamin A helps prevent diseases such as diarrhea, respiratory ailments, tuberculosis, malaria and ear infections, and helps prevent transmission of Human Immunodeficiency Virus from mother to child. According to the World Health Organisation (WHO), around 2.8 million children under five years of age currently exhibit a severe clinical manifestation of vitamin A deficiency known as xerophthalmia. It has been demonstrated that vitamin A could lower childhood mortality by about one-third in many parts of the developing world. VAD is considered a serious public health problem and several high level initiatives have been launched with the goal of eliminating VAD in 2000. Progress has been made, but the goal is still a long way off.

Deficiency of a single micronutrient seldom occurs in isolation. In many countries, malnutrition with significant health consequences results from deficiencies in zinc, vitamins C and D, folate, riboflavin, selenium and calcium , in addition to the three micronutrients to which so much attention is now given (vitamin A, iron and iodine). VAD is mostly prevalent amidst poverty, environmental deprivation and social disparity. It is considered as one of the components – and a minor component at that - of the syndrome of undernutrition Hence, in the context of multiple nutrient deficiencies and interrelationships of nutrients, the use of a single nutrient to combat micronutrient malnutrition does not make sense.

Vitamin A or retinol, is present exclusively in animal foods such as liver, milk and eggs. Fruits and vegetables contain provitamin A, such as beta-carotene and other carotenoids, which first need to be converted into retinol before the body can utilise them (see example in the table below). The origins of vitamin A deficiency in childhood can be traced to poor nutrition status of the mother during pregnancy and lactation, and inadequate intake of foods rich in either preformed or provitamin A by the infant after weaning and thereafter. A logical approach then to the prevention of vitamin A deficiency must seek to address these basic causes and not rely on technological fixes. Fortunately, the abundance of natural foods in the South should make such dietary improvements possible.

Farms not pharmacies!

Three measures are currently being employed worldwide to control vitamin A deficiency: supplementation, food fortification and dietary diversification. Most of the current strategies worldwide rely heavily on health interventions - usually the administration, at periodic intervals, of massive oral dosages of synthetic vitamin A supplements to children under three years of age. This strategy was pioneered in India in the late 1960's. What was originally envisaged as a short-term measure to dietary improvement has become the centerpiece of many current programs. UNICEF estimates that half of the children in the world at risk of vitamin A deficiency received at least one dose of vitamin A in 1998. The ease of supplementation has left research into and promotion of dietary measures in the background.

This 'drug-based approach' to synthetic vitamin A distribution has received wide criticism, even from the very individuals who have pioneered the work. Some of the limitations cited based on the 30-year experience of India are: ineffectiveness in correcting VAD (especially in populations where milder signs of deficiency are widespread), the limited shelf-life of vitamin A and logistical problems in ensuring supply. Supplementation programs are often expensive and unsystematic, and coverage may be poor. There have been many calls for an alternative approach, addressing the root causes of the problem rather than treating the symptoms. The World Declaration and the Plan of Action on Nutrition, adopted by 159 countries, at the International Conference on Nutrition jointly organized by the UN's Food and Agriculture Organisation (FAO) and WHO in 1992,

Micronutrient content of drumstick leaves compared to other foods (per 100g edible portion)

Nutrient	Drumstick leaves	Other foods
Vitamin A activity (mcg)	1,130	Carrots: 315
Vitamin C (mg)	220	Oranges: 30
Calcium (mg)	440	Cow's milk: 120
Potassium (mg)	259	Bananas: 88
Protein (mg)	6,700	Cow's milk: 3,200

Source: C Gopalan *et al* (1994), *Nutritive Value of Indian Foods*, Nat. Institute of Nutrition, India

states that strategies to combat micronutrient malnutrition should: *"Ensure that sustainable food-based strategies are given first priority particularly for populations deficient in vitamin A and iron, favouring locally available foods and taking into account local food habits."*

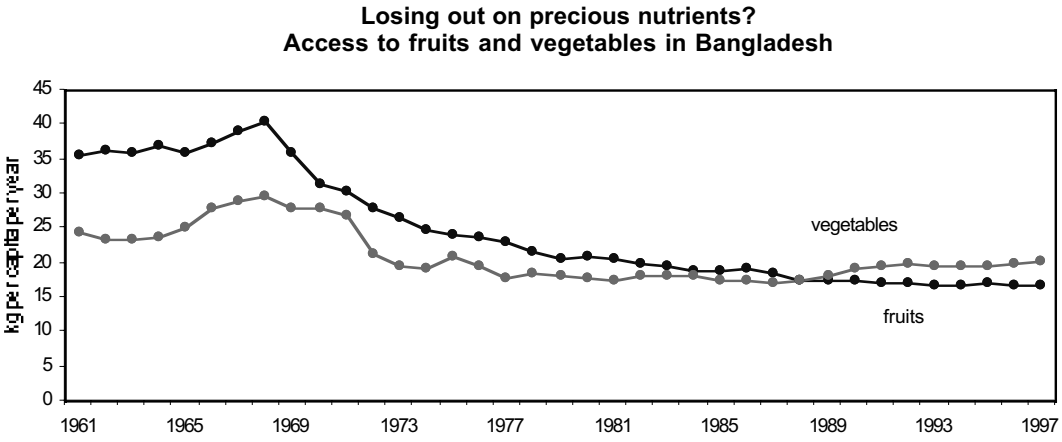
The fortification of butter, margarine and sugar with vitamin A is already being implemented in some countries. It too has drawbacks. In most instances, food fortification is only feasible in countries that possess well-developed, efficiently monitored and properly regulated pharmaceutical and food processing sectors. Like supplementation, fortification does not lead to awareness building and changes in dietary habits, and its impact is limited to those who can access these fortified products. Dietary diversification, on the other hand, requires minimal foreign currency; it promotes the intake of a whole range of micronutrients other than vitamin A; it is sustainable; it fosters community and individual involvement; and it can even help stimulate the local economy.

The Green Revolution: feast and famine

The prevalence of micronutrient deficiencies now far exceeds protein and calorific malnutrition in Asia. Despite substantial increases in cereal supplies, which have contributed to increased intake of calorie- and protein-rich foods, the supply and consumption of foods rich in micronutrients have not increased proportionally, and in many cases have actually declined. Only 30 crops 'feed the world,' providing 95% of dietary energy and protein requirements. More than half of these come from wheat, rice and corn alone. For this reason, these three crops served as the cornerstone of the Green Revolution in the 1960's. Monocultures of these crops were encouraged , which resulted in the growth of a food supply that provided more macronutrients but did not provide the much-needed micronutrients, which were already in short supply. In some cases, the availability of and access to micronutrient rich food crops actually decreased for millions of poor people. Today, more than 2 billion people consume diets that are less diverse than 30 years ago, leading to deficiencies in micronutrients, especially iron, vitamin A, iodine, zinc and selenium.

Drumstick *(Moringa oleifera):* beats vitamin pills

Varietal replacement of traditional varieties in the field, which is reported to be the major cause of genetic erosion around the world, also had its impact in home gardens. A farm household survey in the Republic of Korea, for example, revealed that out of 143 crops cultivated in home gardens in 1985, only around 26% of landraces remained cultivated by 1993. These results are disturbing since such home gardens have traditionally been important not only as conservation sites especially for vegetable crops, but also an important source of vitamins and minerals.



Source: Compiled by GRAIN from FAO Food Balance Sheet, updated 21 June 1999

A significant and consistent decline in per capita consumption of green leafy and yellow vegetables had been noted in Philippines. The same is true for vegetables, fruits, pulses and spices in Bangladesh (see graph above). This situation caused the Director of the Horticultural Research Center of Bangladesh Agricultural Research Institute to suggest that *"Food patterns could have been changed and we could have attained self sufficiency in food and nutrition much earlier with 300 g cereal/capita per day as against achieving food self sufficiency today with 500 g cereals."*

It is becoming evident that the Green Revolution represented a trade-off between quantity and quality in peoples' diets, especially amongst the poor. Even the International Rice Research Institute (IRRI) admits that the Green Revolution may have actually increased micronutrient malnutrition among the poor. But IRRI can not look beyond the Green Revolution model for a solution to this problem, and is looking to genetic engineering to get it out of the hole it has dug for itself. Like many other international organisations involved in agricultural development, IRRI sees the answer to micronutrient malnutrition in engineering the missing elements back into Green Revolution crops. Some of the most advanced research in this arena is on engineering vitamin A into rice and mustard plants. These vitamin A crops are being hailed as evidence that genetic engineering holds promise for the poor as well as the rich, and that transgenic crops can benefit humanity as well as generating profits for the gene giants. This new approach is expected by many to supplant existing strategies for dealing with VAD, hopefully overcoming their limitations.

Engineering vitamin A into crops

Vitamin A rice was showcased in *Science* in August 1999. This genetically-engineered rice produces beta-carotene in its endosperm, giving it the distinct yellow colour that affords it the name 'golden rice.' The rice was developed with funds from the Rockefeller Foundation and the European Commission. Since it has been developed outside the private sector, 'golden rice' has become a much-needed and timely public relations tool for the promoters of genetic engineering. At the same time, Monsanto had been developing a high beta-carotene mustard plant which it planned to offer to poor subsistence farmers around the world. Through the *Global Vitamin* A partnership and local stakeholders, Monsanto promised to develop appro-

priate varieties of crops for those areas in greatest need. This donation allowed Monsanto to make a strong case for the relevance of agricultural biotechnology to the problems faced by the world's poorest, to get the technology adopted on the grounds of public good, and to counter the very bad reputation it had earned itself, particularly in Europe and India.

'Golden rice' is the product of two German research teams under the direction of Dr Ingo Potrykus of the Swiss Institute of Technology in Zurich, and Dr Peter Beyer of the University of Freiburg. The idea of genetically engineering beta-carotene into rice emerged nine years ago, in the light of UNICEF and WHO reports on the high incidence of VAD in countries where rice serves as a staple food. The researchers engineered a laboratory variety of *japonica* rice (Taipei 309, adapted to temperate weather in Europe) to convert a naturally-occurring hormone precursor into beta-carotene. The team has added three genes, two of which are new to genetic engineering and come from daffodils (*Narcissus pseudonarcissus*). The third comes from a bacterium, *Erwinia uredovora*, which has been already used by Kirin Brewery. The teams are also working to cross this new line with another rice line to increase its iron content.

The amount of hype given to 'golden rice' seems a little premature given that only a handful of genetically engineered seeds have so far been developed. All that is certain is that some of the transformed seeds contain beta-carotene in the endosperm, but it is not yet clear whether or not it is available for absorption. Even if the rice proves to be a success, the beta-carotene trait still needs to be transferred to the *indica* rice varieties, the types grown in Asia. This work will be done by several of the International Agricultural Research Centres (IARCs), including the Philippine-based IRRI, the India-based ICRISAT and the Colombia-based CIAT where further cross-breeding and field testings will be done. IRRI, together with the Philippine Rice Research Institute, is set to transfer the golden trait to widely-grown varieties such as IR64.

Vitamin A rice has a long way to go still. Success in the laboratory means little in the field. Transgenic plants which perform well in laboratories often fail in nature, especially if they contain not one, but three added gene-constructs. Environmental impact can only be speculated on at this point, and issues such as palatability and public acceptance may also pose problems. The whole project does not seem to have been thought through very well. Potrykos' and Beyer's teams contacted international institutions with experience in VAD, such as UNICEF, FAO and the WHO, only *after* the project was well underway. Had they done so prior to undertaking the research, the project might well never have happened. The research team has consisted of plant scientists and a nutritionist, and issues related to extension and public acceptance have not been addressed. Consumers may very well react against a rice which is yellow instead of white. If public education is needed, wouldn't it be better to use such efforts to promote dietary diversification which would improve overall nutrition rather than simply supplement a single vitamin?

While the development of vitamin A rice seems to be well-intentioned, if perhaps misdirected, Monsanto's beta-carotene mustard comes from more questionable roots. Calgene, which was bought by Monsanto in 1996, first developed rapeseed (*Brassica napus*) with elevated carotenoid levels because it contained higher proportions of fatty acids, making it potentially more profitable. Unlike the 'golden rice' initiative, the objective was purely commercial. Transferring the technology to mustard (*Brassica juncea)*, a close relative, was an afterthought.

It seems unlikely that it is pure coincidence that Monsanto's idea to create beta-carotene mus-

tard has come at a time when mustard, which is the most important oil crop in South Asia, is being pushed into the marketplace. Monsanto is present in the Indian seed market through its agreements with Mahyco and its ownership of Cargill. Monsanto's donation appears within the context of mustard's transformation into an international trade commodity and the company's desperate attempts to gain credibility and support for its transgenic crops in India. Although the company is ready to share the technology with any interested party, only the new Delhi-based TATA Energy Research Institute is mentioned by Monsanto as a potential partner – hardly one of the *"local stakeholders"* it talks about. It may take more than beta-carotene mustard for local farmers to trust the corporation they see as at least partially responsible for their own hardships.

Monsanto's new R&D center at the Indian Institute of Science in Bangalore is responsible for transferring the beta-carotene technology from rapeseed into mustard varieties, which it hopes to do by the end of 2000. Field testing will take a further 2 to 3 years. Meanwhile, many questions remain. Since beta-carotenes are fat-soluble, Monsanto expects that the oil from its transgenic mustard will be readily absorbed by the human body. However, heat destroys beta-carotene, and mustard oil is most often consumed after cooking, so the beta-carotene needs to be stabilised somehow. Another drawback is that the modified rape seed oil is orange, which could affect public acceptance.

Tangled up in patents

Despite all the publicity, the promises of 'golden rice' and Monsanto's rapeseed are still far from being realised. One issue that has been largely beyond the scope of the press debates is that of intellectual property rights associated both to the Monsanto rapeseed and, perhaps less evidently, to the golden rice. In the case of Monsanto, the company owns – through

Patents on the 'Golden Rice'

Processes and sequences	Patent number	Owner
Agrobacterium transformation	WO8603776 (1986)	Plant Genetic Systems (Aventis)
Daffodil PSY and LYC genes	Pending	University of Freiburg
Erwinia uredovora CrtI gene	EPO393690 (1990)	Kirin Brewery
Carotenoid biosynthesis gene	WO9806862 (1998)	Calgene (Monsanto)
Endosperm-specific Gt1 promoter of daffodil genes	J6391085 (1988)	Noriinsho
CaMV 35S promoter of *E.uredovora* gene	US5106739 (1992)	Calgene (Monsanto)
AphIV marker gene	US5668298 (1997)	Eli Lilly

Source: Compiled by GRAIN from Xudong Ye *et al* (2000), Derwent Biotechnology Abstracts and Esp@cenet

Calgene – the patent on the beta-carotene rapeseed (WO9806862), and on the promoter (napin promoter: US 5,420,034). It is bound to pay royalties to the developers of the transformation method it has used to produce the transgenic rapeseed and to Kirin Brewery for the carotenoid biosynthesis genes from the bacterium *Erwinia uredovora* (EP0393690).

Monsanto has announced that it aims to provide the high beta-carotene mustard free of charge to poor and subsistence farmers *"not fully participating in the world economy."* However, what this means is not clear. What will be the limit for the sale of the rapeseed or its oil? How would such limitations affect the availability of the beta-carotene oil to the poor? Will they affect the purchase of the seeds or oil by large national or international corporations? Sources from Monsanto's R&D Institute say that while the project is philanthropic, the company has no clear policy to answer these questions.

In the case of the 'golden rice,' its developers claim that it will likely be given free of charge to the farmers. Whether this claim will be realised is still up in the air given the patent hurdles it faces. Despite being funded by public sector, the 'golden rice' is to a large extent the product of private companies.

The development of the rice has involved patented processes, genes and promoters, which amount to at least six previous patents (see table opposite). On top of these, the teams of Zurich and Freiburg have filed a patent application covering the insertion of the metabolic pathway to produce beta-carotene in seeds. The scientists involved claim this was to prevent other parties (corporations) from patenting the technology. If this is really the case, it would have been enough just to release the information into the public domain. Applying for the patent turns the Rockefeller Foundation and the European Commission into potential for-profit institutions. According to Beyer, the patent application that has been filed covers the insertion of the new metabolic path in any crop, not only rice. Rice will be the only crop freely available to farmers, and only under certain circumstances as specified in a contract between the 'inventors' and the IARCs transferring the genes for the 'golden rice' into tropical varieties.

This is not the first agreement between private sector companies and IARCs to use and distribute patented materials. Ciba-Geigy (which merged with Sandoz to form Novartis) made Bt genes available to IRRI to develop rice, and the rice produced with this gene is freely available to rice producers in all countries except Australia, Canada, Japan, New Zealand, United States, and members of the European Patent Convention as of 1994. Plant Genetic Systems has provided the Centro Internacional de la Papa (CIP) with Bt genes and technologies, and the results of collaborative research are freely available for developing countries, provided the recipient does not appropriate them unfairly or seek profit through their commercialisation in industrial countries. The control must remain, after all, in the hands of the patent holder.

The teams behind the 'golden rice' believe that, if only for the sake of their public image, no company will prevent them from using their patented processes, genes or promoters to make rice freely available for the poor. But it is a complicated arena because a conflict of interest could easily arise for the companies involved, particularly given that they have only made their technologies freely available for use under certain circumstances. However philanthropic the intentions of the project, the products of genetic engineering are so entangled in IPR issues and directed towards the profit motive, conflicts are almost certain to arise. Charitable initiatives may easily be corrupted and derailed because of the private sector's ownership of key genes and patents.

Will biotech solve the problem?

The unveiling of 'golden rice' is giving impetus to the application of genetic engineering to combat micronutrient malnutrition. But it is highly unlikely that poor people stand to benefit from this strategy. This 'band aid' approach will merely perpetuate the declining quality of food grown under the industrial agricultural system at the expense of fruits, vegetables, and underutilized and wild crops. Without shifting the focus of nutrition efforts towards a more diverse agricultural base, there is no doubt that micronutrient deficiency will persist. The real impacts of vitamin A crops will be:

- ***Reducing dietary and nutritional diversity***

Focusing on engineering micronutrients into staples instead of promoting natural sources will further skew agricultural research and development and consequently food availability further away from diversity. It will perpetuate the commodity bias towards staples or a limited range of so-called functional foods such as high beta-carotene oil. This will exacerbate genetic erosion, decimate farming systems and reduce nutritional diversity.

- ***Decreasing overall nutritional status***

The very narrow target of just providing a single micronutrient such as vitamin A into commonly consumed crops will do little to overcome micronutrient deficiencies. The transfer of an exotic gene into a monoculture crop can do little to make up for the dietary deficiencies of those suffering from monoculture malnutrition. The nutritional value of a combination of rice and *Moringa* (drumstick) leaves is far greater than that of the 'golden rice'. Providing only a single micronutrient via food to a population which is deficient in a whole range of nutrients could be considered unethical, especially where the whole range can easily be obtained easily from locally-available fruits and vegetables and in wild and underutilised crops.

- ***Perpetuating the problem***

The claim that 'golden rice' or beta-carotene mustard will help eliminate VAD in the South has great appeal. Yet the genetic engineering approach erroneously assumes that VAD exists due to a general lack of vitamin A food sources. This type of intervention tends to maintain the *status quo*, where rice remains to be the predominant food in poor peoples' diets, instead of encouraging people to diversify their food sources. Instead of solving the problem, it merely masks the shortcomings of the Green Revolution and perpetuates the problem.

- ***Promoting technical fixes again***

This one-dimensional technical fix approach to VAD is reminiscent of the Green Revolution paradigm. This was another techno-fix solution to a complex problem: that of poverty and hunger. 'Golden rice' is another simple, universal solution to the problems of the poor decided upon and developed by scientists from the North. It comes as no great surprise that the Rockefeller Foundation, one of the main architects of the Green Revolution, has been financing this approach to solve a problem which it helped to create in the first place.

- ***Accessibility and equity***

The *"poor"* are a major target for vitamin A crops. Yet many of the poor, particularly women, have not benefited from Green Revolution crops, so it is unlikely they will benefit from the next wave. Any direct benefit to the poorest, who by definition have little purchasing power thus generate little of a market, is to be generated as a side effect, or an exception to the rule, upon which the poor do not have any control. Scarce resources should be directed, instead, to policies that have the poor as their main objective, not as incidental beneficiaries.

- ***Dietary diversification or uniformity?***

Although improved dietary habits, particularly the increased production and consumption of

TAPPING THE NATURAL PHARMACY

Sources of vitamin A are abundant. However, the contribution of such plants to alleviating micronutrient deficiencies is greatly underappreciated. Among the wide range of green leafy vegetables, drumstick leaves (*Moringa oleifera*) provide a particularly rich and inexpensive source of pre-formed vitamin A and other important micronutrients. Native to India, the tree grows abundantly in all tropical countries where vitamin A deficiency is a problem. A glassful of infused *Moringa* leaves contain the daily requirement of vitamin A for up to ten people.

Tum leung (ivy gourd) has been the subject of a successful educational project in Thailand which helped improve knowledge, attitudes and practices. Through the project almost 5,000 households began to grow *tum leung* in their gardens, demonstrating that given the right education tools, the poor can be very receptive to changing their eating habits.

In West Africa, one of the richest sources of vitamin A is the oil of the oil palm *Elaeis guineensis.* The oil is now being actively being promoted by FAO in certain parts of Benin, Ghana, Nigeria and northwestern Tanzania. One of the ways of increasing access by the poor to this nutritionally valuable plant is to raise extraction yields by improving village technology. This strategy has also been successful in Zambia, where FAO introduced tenera palms from Costa Rica. In Brazil a local tree called *burité* produces oil as rich in beta-carotene as the oil palm, and this is being promoted as part of national efforts to prevent vitamin A deficiency.

Crop/Vegetable	Description (per 100g)	Vitamin A activity (mcg)
Amaranth	leaf, raw	900-1,543
Carrot	leaf, raw tuber, raw	1,200 2,840
Bitter gourd	tuber, cooked	2,210
Finger millet	flour	4
Potato	tuber, white, raw	3
Sweet potato	tuber, yellow, raw leaf, raw	50-770 183-450
Buriti palm	oil	50,667
Red palm	oil	2,035-24,647
Kale	leaf, raw	150-1,263
Radish	leaf, raw	883

beta-carotene-rich foods, have long been advocated as the only acceptable long-term solution to combat VAD, very few concrete steps have been taken in this direction in the past twenty years. In the words of the 1991 laureate of the World Food Prize, Dr. Nevin Scrimshaw: "*It is ironic that some of the worst concentrations of xerophthalmia and blindness due to vitamin A deficiency occur in populations surrounded by abundant sources of the vitamins and minerals in local vegetables and fruits, yet, no country has yet mounted a successful campaign to solve the Vitamin A problem in this way".*

Breaking the cycle

Supplementation and fortification programmes treat the symptoms but not the underlying cause of micronutrient malnutrition. Poor quality diets consisting primarily of staple foods are the underlying cause of micronutrient malnutrition. 'Golden rice' is merely an extension of the supplementation approach and also fails to address the cause. Even worse, it actually perpetuates malnutrition because it fails to address peoples' requirements of other minerals and vitamins, which would be met by adopting a dietary approach to VAD.

Improving dietary diversity by stimulating the production and consumption of micronutrient-rich foods is the only sane and sustainable approach to overcoming micronutrient deficiencies. There is a great scope for improving direct household supplies to such foods in rural and urban areas (see box on p 17). The real cause of VAD is that vulnerable populations are not empowered enough to access these natural sources of vitamin A. This should be the starting point of any strategy to combat VAD. Diversity is the basis of balanced nutrition. Agricultural and nutritional policies should promote the availability of micronutrient-rich foods and targeted nutrition education programs should help increase their consumption. Only by providing a diversity of food sources in the field and by increasing awareness of food's relevance not just to fill the bowl with calories but to improve nutritional well-being, can we break away from the vicious cycle of hunger and malnutrition. ⌘

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Ivy gourd *(Coccinia grandis)*: more Vit A than carrots

GENOMICS: WHOLE GENOME, TOTAL CONTROL

GRAIN

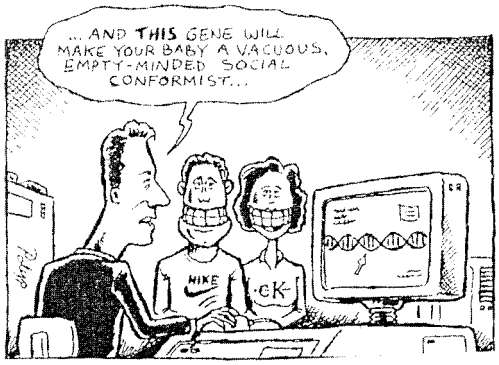
Over the last few years, the pharmaceutical and agricultural industries have started to invest heavily in genomics research, which they see as the lynchpin for future research and product development. Crop genomics, we are told, will overcome the limitations of current genetic engineering techniques and open up a whole new world of possibilities. Bold promises are being made about the contributions this science can make towards feeding the world, redirecting agriculture towards sustainability, and even increasing agrobiodiversity. This article examines the state of the art in crop genomics research and critically assesses these claims.

The birth of the science of genomics has sent the race to appropriate and exploit the genes of humans, animals and plants into high gear. Genomics is the study of all the genes of a given species and the way in which they interact in order to generate the characteristics of that species. Genes are the future currency of both the pharmaceutical and agricultural industries, and genomics is the tool researchers are looking towards to help develop new drugs, foods and industrial products. Companies involved in genomics research are not shy in their predictions. *"Death is a series of preventable diseases,"* claims the head of Human Genome Sciences.

Genomics research began in earnest with the launch in the US of the Human Gene Project (HGP) in October 1990, a public sector initiative to map the whole of the human genome. Hyped as the greatest endeavour ever undertaken in the field of biological medicine, the HGP has been funded to the tune of $US 2.2 billion. Since then, at least 18 countries have established human genome research programmes: mainly industrialised nations, but also Brazil, China and Mexico.

HGP findings were intended to be made public in order to support further research efforts. However, one of the scientists from the project left to set up his own private company, Celera Genomics, in direct competition with the HGP. Because the company used a different (and more crude) technique from researchers in the HGP, Celera claimed that it could sequence the whole genome in less than three years and at a fraction of the cost ($US200 million). Celera's challenge to the HGP signalled the start of the race for the human genome, and it was soon joined by numerous other start-up companies looking to capitalise on this new source of potential wealth.

Pharmaceutical companies have been eager to enter into agreements with these start-ups in order to appropriate genes involved in profitable illnesses. They have collectively invested more than US$1.8 billion in such alliances, excluding in-house efforts. Research activity has been translated into a wild frenzy of patent applications as companies try to gain proprietary control of the genome. Celera and Human Genome Sciences have filed for preliminary patents on 6,500 and 6,700 human gene sequences respectively, while Incyte has filed patent applications covering an estimated 50,000 individual human genes. In most cases, the companies have little or no idea about the gene or gene fragment's function, which should automatically result in the applications being turned down. But the companies are undeterred, since



ASEED (see review on p 36)

plenty of patents have already been awarded for products lacking the inventive step and evidence of usefulness.

Competition between private and public concerns has accelerated sequencing efforts. Celera claims to have sequenced almost three quarters of the genome and the HGP is planning to release its 'first draft' this spring. Concern is rising in scientific and political circles that privatisation of the human genome will hamper medical research and the benefits thereof. In September 1999, the UK and the US governments announced that they were drawing up an agreement to prevent patenting of the human genome. But this has not yet translated into action, and it seems highly unlikely that the US in particular will follow through, having already granted some 1,500 patents on human DNA and being the home of all the leading genomics companies.

Unravelling crop genomes

Research in plant genomics has been much lower profile than human genome research, but many scientists believe that practical results of genomics research will be manifested in the agricultural field long before those in the field of human health. Industry, with its myopic view of the future of agriculture being rooted in genetic engineering, sees a genomics approach as essential. The modifications that can be introduced into a plant through genetic engineering are currently very limited: only those traits regulated by one to three genes can be engineered with some effectiveness. But such traits are the exception, rather than the rule. Researchers are finally taking notice of the fact that gene relationships and interactions are as important as their individual effects. Genes operate together as a system, and their effects are more than the sum of their parts.

Most of the traits of economic relevance for industrial agriculture – such as yield, stress tolerance, salinity tolerance, nutrient content – are the result of complex interactions between a number of genes and their environment. The single gene approach to genetic engineering is already reaching the end of its short life, and a genomics approach is seen as the natural next step. Although the endeavour is huge, fortunately for the researchers it has been found that plants are genetically very conservative, meaning that the genes that code for plant traits and processes are nearly identical across a wide range of species. This makes their task a great deal easier.

The model plant that has received greatest attention so far is *Arabidopsis thaliana* or wild mustard, a dicotyledonous plant with one of the smallest known plant genomes. Rice was the obvious choice amongst monocotyledons, because it is not only economically very important, but its genome size is six times smaller than corn and 37 times smaller than wheat.

For the public good?

From the start, plant genomics initiatives have been influenced greatly by the private sector agenda. In 1995, the first high-profile corporate call for public investment on plant genomics was the US National Corn Initiative (NCI). Heavily backed by industry and carrying the

slogan *"The future of the corn industry is written in the genetic code,"* the NCI is being touted as *the* way to ensure continued US dominance of the international corn market. Industry's strategy has been to obtain government funding to sequence the entire corn genome. The results would be protected under patents owned by the US government, which would make them available to the US research community – that industry itself dominates.

Industry has also welcomed the US National Plant Genome Initiative (NPGI), an interagency strategy to fund plant genomic projects. Among its goals are participation in international genomics collaborations – mainly the sequencing of *Arabidopsis* and rice genomes – and the development of genomics technology. The NPGI was funded to the tune of US$40 million in 1998, US$50 in 1999, and is projected to reach US$145 million in 2000. Virtually all the projects funded so far have been granted to universities and non-profit research institutes, although these include also Venter's Institute for Genomic Research, which is closely tied to Venter's for-profit Celera Genomics. The bulk of the money has gone to functional and mapping projects, and corn has been the main target crop, with 13 projects approved and US$55.5 million awarded. The NPGI has also

GENOMICS: STATE OF THE ART

There are currently three main fields in genomics research:

Structural genomics deals with mapping and sequencing genes and is the basis of all genomic work. Structural genomics research is a major focus for public institution, comprising virtually all of EU genomics funding and more than one third of US funding. It is also the domain of companies such as Celera and Human Genome Sciences, Incyte (which has a sophisticated database system allowing subscribers to use their sequencing information and also files patents for gene sequences), and Myriad Genetics (infamous holder of the patent on several cancers related to breast cancer).

Functional genomics involves identifying functions of gene sequences. The aim is to to analyse when and how which genes work together in order to generate a trait. Companies active in this arena include Synteny (now owned by Incyte), Affymetrix, Clontech, Research Genetics and Vyis. The technologies are extremely expensive, precluding their use in the public sector, even in the US.

Bioinformatics tries to make sense of the information derived from the above techniques. The importance of this science become obvious when one considers that the human genome contains 100,000 genes comprising three billion base pairs. The development of bioinformatic tools that enable exploitation of gene sequences is now the stated priority of many companies. As Craig Venter has put it, *"Getting the human genome is just the beginning — the sequence is the bottom of the totem pole."* Many companies are hopeful that they can make a lot of money out of adding value to the publicly-available gene sequences. The arrival of IBM into the world of bioinformatics is a strong indication that it may soon be one of the leading and most lucrative fields of information technology.

funded four projects focusing on the functional genomics of *Arabidopsis*, and three on mapping the rice genome.

The US government has also activated in-house genomics capacity. The US Department of Agriculture (USDA) announced in January 1999 that it was to establish a new Center for Bioinformatics and Comparative Genomics at the Cornell University, and it was also to acquire eight state-of-the-art automated machines to speed gene sequences. These new capacities were to convert the USDA's Agricultural Research Service into "*the single most powerful force in genome sequencing within the public agricultural research sector.*"

The intellectual property policy of the NPGI is somewhat unclear. The adopted policy is that "*All resources, including data, software, germplasm, and other biological materials should be openly accessible to all*." But, rather feebly, it only promises *"not to patent early-stage research tools and to discourage plant genome initiative grantees or contractors from doing so."* It is obvious that the US public sector is too entangled in patenting itself and feels much too obligated to the private sector to establish a clear non-patenting policy. However sound its intentions, the NPGI will probably end up subsidising industry's work and hammering a few more nails into the coffin of public research.

In the last decade, the European Union has invested EURO 40 million in genomics research. Most of this money has gone towards *Arabidopsis*, the EU having financed the sequencing of 25% of its genome. Some European member states are also undertaking their own genomics initiatives. France has laid its public research sector at the feet of industry through its controversial Génoplante initiative, whose goal is to privatise as a large part of our crop genetic heritage as possible, before other countries do so. The French government is about in invest US$158.9 million in this blatant subsidy to its transnational corporations (see *Seedling* Vol 16, No 3, p17).

Japan's main priority in genomic research has been the sequencing of rice, which it began in the late 1980s. Initially, the involvement of the private sector in the Japanese Rice Genome Research Program (RGP) was so strong that it had to be shut down and set up again. By 1998, the RGP had an annual budget of US$5.5 million for gene sequencing, and a further US$17 million for other genomic research. In 1997 Japan was made permanent chair of the International Rice Genome Sequencing Project (IRGSP), which aimed to map and to sequence all the rice genome by 2008. Current members of the IRGSP are Japan, the US, the EU, Taiwan, Thailand and South Korea. This supposedly open access initiative was to keep all data in the public domain, but has not been free from industry pressure. In order to ensure funding from private companies for the second phase, the Japanese Ministry of Agriculture, Fisheries and Food has deliberately excluded genetic data on the roots and flowers from being released.

In April 1999 Celera (whose non-profit arm, the TIGR, is a part of the IRGSP) offered to sequence the whole rice genome in six weeks for any company willing to pay its price of US$30 million. No company has yet taken the company up on its offer, but the announcement raised concerns all over the world about the proprietary control of plant genetic material, just as Celera's voyage into the human genome had done. The announcement scared the IRGSP into advancing its calendar by almost four years (to 2004) and stepping up its budget. Japan pledged to inject extra funding: in 2000, the country's annual rice genome research budget is to reach US$ 67 million, a threefold increase from 1999.

The other large plant genomics international programme is focused in *Arabidopsis*, which is

known as the *Arabidopsis* Genome Initiative (AGI). The AGI's steering committee comprises representatives from the EU, Japan, US – including both University consortiums and the private sector – and France. It is now estimated that the entire sequence of *Arabidopsis* will have been sequenced by the end of 2000.

While plant genomics is given an increasing priority in the main economic nodes of the North, the South remains almost completely marginalised. The science of genomics will polarise even further the haves and have-nots in agricultural research, because of the astronomical cost of seqencing machines and technologies to interpret the data they produce. At the moment, the only large sequencing project that directly involves countries from the South is the IRGSP, of which Thailand is a member country. Only three of the International Agricultural Research Centres (IARCs) of the Consultative Group on International Agricultural Research (CGIAR) are planning any involvement in genomics: ILRI intends to use genetic markets of disease resistance for selection of breeding stock to develop improved high-resistant livestock; ICRISAT is setting up an Applied Genomics Laboratory to develop molecular strategies, techniques and analyses to enhance the use of the accessions stored at ICRISAT's germplasm bank and to investigate pathogens; and IRRI is about to hire a bioinformatics specialist to integrate molecular and genomic data with the information generated through more traditional approaches to the study of rice.

As for developing countries themselves, Brazil is the first country in the South to have completely sequenced a species' genome. It has been working on the bacterium *Xylella fastidiosa*, which it claims is be the first crop pathogen to be fully sequenced.

In 1998, India invested US$250,000 in a Plant Genome Research Centre at the Jawaharlal Nehru University in New Delhi. In March 1999, the Indian government announced an initiative to sequence the entire genome of chickpea there, with a budget allocation of US$4 million. The Indian government stated its interest in this particular crop because it considers that no other government will be interested in it – perhaps somehow underestimating the interest that Australia has clearly shown in it. However, difficulties have already been reported as Indian scientists are drawn towards Monsanto's US$ 25 million genomic research centre in Bangalore, which offers better salaries and rosier job prospects.

The private sector dives in

Pioneer Hi-Bred International, which is being bought up by DuPont, was the first seed company to venture into the genomics arena. Having failed to convince the US government to invest in genomics research, it decided to go it alone. In January 1996, it teamed up with Human Genome Sciences (HGS). In exchange of US$16 million, HGS was to sequence the genes in Pioneer's corn gene bank. Pioneer would own all the gene sequence information and intellectual property rights resulting from the collaboration. In this way, 'lord of the gene' Pioneer had set itself on the path to becoming 'lord of the genome.' Meanwhile, it continued to encourage the US government to undertake its own corn sequencing programme, hoping to have free access to the results of public research, while holding its own cards tight to its chest.

The next significant move came when Monsanto announced an strategic alliance with Incyte Pharmaceuticals in October 1996. Monsanto would have exclusive access to Incyte's plant genome database – presumably generated from samples provided by Monsanto, but remaining under the control of Incyte – with Monsanto paying Incyte part of any future royalties gleaned from sales of products developed through the agreement. These two basic ap-

Table 1: Some agreements between agbiotech companies and genomics companies and institutions

AG. COMPANY	GENOMICS	DATE	COST (M$US)	CROPS
Agriobiotech	Global Agro (Salk Institute of Biological Studies)	1998	Equity stake	Forages
Aventis (AgrEvo)	Lynx Therapeutics	1999	4	?
Aventis (Rhobio)	Genoplante partners (INRA, CIRAD etc)	1998	68.1 (cos.)	French crops
Aventis (Rhobio)	Celera AgGen	1999	?	Corn
Aventis (Rhone-P)	Inst. for Molecular Studies (Singapore)	1999	?	Rice
Aventis (Agrinomics)	Vilmorine Clause & Cie, Biotech MAH Plant Genomic Fund*	2000	?	Vegetables
Dow Agrosciences	Biosource Technologies	1998	?	?
DuPont	John Innes Centre, Sainsbury Lab., UK	1998	JIC 24.4	Wheat
DuPont	Lynx Therapeutics	1998	22-60	Corn, soy, wheat, rice
DuPont (Pioneer)	Human Genome Sciences	1996	16	Corn
DuPont (Pioneer)	Affymetrix	1997	?	Corn
DuPont (Pioneer)	CuraGen	1997	20	Corn
DuPont (Pioneer)	Maxygen	1999	35-85	Corn
Monsanto	Incyte Pharmaceuticals	1996	?	?
Monsanto	ArQule	1997	12 + royalties	?
Monsanto/Savia**	Mendel Biotechnology	1997	30	Fruits, veg, corn, soy
Monsanto	Millenium Pharmaceuticals	1997	218	?
Monsanto	IBM	1997	?	?
Monsanto	Genetrace	1998	17.2	Also animals
Monsanto	Paradigm Genetics	2000	55 + ?	?
Novartis	Clemsen University	1998	3	Rice and rice blast
Novartis	Diversa	1999	12.5	?
Novartis (NADI)	Berkeley University	1998	25	?
Novartis (NADI)	Myriad Genetics	1999	33.5	Cereals

* Fund is co-managed by Makhteshim-Agan Industries of Israel, one of the world's main generic pesticide producers.
** Savia is the name of the company formed by the merger of Empresas La Moderna and seguros Comercial America
Source: compiled by GRAIN

proaches to the control of genomic information – owing and patenting sequences or paying user fees for accessing value-added information without actually owning the sequences – now characterise most joint ventures in this field.

In the last three years, the agricultural genomics scene has changed dramatically. Access to and control of complex genomic information is now perceived as the cornerstone for the future development of transgenic plants, and the leaders of the agroindustrial genetic complex have entered a race for being the first to identify – and hopefully own – the genes involved in the regulation of commercially interesting traits and their interactions. Private sector investments in the last four years have already greatly exceeded the investments made by public sector on model plants. These companies are now courting genomics start-ups just like the pharmaceutical industry has been doing since the early nineties (see Table 1). The situation is reminiscient of the early nineties, when a number of biotechnology start-up companies (such as Plant Genetic Systems and Calgene) serviced their genetic engineering needs. The start-ups ended up being ingested by the transnationals, a move that may well be played out in the genomics field.

One of the highest bidders for plant genomics is Novartis, which is investing about 10% of its agricultural R&D budget on genomics. In 1998, the company invested a breath-taking US$600 million in a brand new genomics research centre in La Jolla, California: the Novartis Agricultural Discovery Institute (NADI). NADI is focusing on *"understanding the basis of crop performance and finding genes outside plants that could improve health and nutrition,"* and is collaborating with academia and genomics companies. Aventis is also investing heavily in genomics, mainly via Rhobio, a joint venture between Rhone Poulenc and Biogemma (co-owned by Limagrain). It is no small significance that this joint venture between the largest French agrochemical and seed business was launched just five months after the birth of Gènoplante, in which France offered up its public research to these very companies. Pioneer Hi-Bred, and its new owner-to-be, DuPont, are positioning themselves as the leaders in corn and soybean genomics respectively. According to Doyle Karr of Pioneer, the companies' combined efforts have already *"identified more than 90% of the DNA sequencing in corn genes."* And Monsanto, of course, which hates to be left out of anything, has bought up Millenium's sequencing technology, created a genomics subsidiary, set up a genomics research centre in India and started working with IBM in the field of bioinformatics.

As interest in genomics gears up, the interface between the private and public sector is becoming increasingly blurry: in fact, France's Gènoplante initiative seems to remove it altogether. NADI's agreement with the genomics section of Berkeley's Department of Plant and Microbial Biology is almost as blatant. Berkeley is to own all patents arising from the US$25 million agreement, and to collect royalties from them. Meanwhile, Novartis will receive first rights to negotiate for 30-40% of the discoveries (the company gets to select which) made in the department, since it provides 30-40% of the funding. Novartis also has rights to review scientific manuscripts 30 days before they are submitted for publication, in order to assess potential business applications. The UK's John Innes Centre and Sainsbury Laboratory have struck up long-term research alliances with Zeneca and DuPont, and Germany's Max-Planck Institute has teamed up with AgrEvo (Aventis).

Gaining control

The rationale industry has for investing in plant genomics is to extend the technological and legal frameworks for genetically engineered crops

Table 2: Work and IPR agreements between some agbiotech companies and genomics partners

AG. COMPANY	GENOMICS PARTNER	WORK	AGREEMENT	IPRs
Aventis (AgrEvo)	Lynx Therapeutics	E	AgroEvo subscribes to Lynx services under a non-exclusive agreement.	
Aventis (Rhobio)	Sigma/Serasem; Florimond Depraz and public sector Gè noplante partners		Gè noplante initiative: to maintain competitiveness in research; to create a European dimension to Genomics.	Programme aims todevelop 'dynamic' intellectual property.
Aventis (Rhobio)	Celera AgGen	E		Celera receives royalties for products developed by Rhobio.
Aventis and Agritope (Agrinomics)	Vilmorin Clause & Cie (France); Biotech MAH Plant GenomicFund (Israel)	S	Agrinomics to conduct research for the joint venture. Aim is to develop pest- and stress-resistant crops.	Research and licensing agreement.
Dow Chemical & Dow Agrosciences	Biosource Technologies	E	To create specific crop traits by combining genomics and assay technologies.	Will seek patents on discoveries.
DuPont	John Innes Centre, Sainsbury Laboratory (UK)		Research alliance to develop new wheat varieties using DuPont's genomics techs.	
DuPont	Lynx Therapeutics	E		
DuPont (Pioneer)	Affymetrix	E	Affymetrix supplies Pioneer with custom DNA chips to monitor corn gene expression	
DuPont (Pioneer)	CuraGen	E,B		Pioneer has rights to seed/ag prods; CuraGen to health prods; royalty sharing on all products.
DuPont (Pioneer)	MaxyGen	F	Optimisation of commercially interesting genes	Will seek patents on discoveries
DuPont (Pioneer)	Human Genome Sciences	S	HGS sequences DNA from Pioneer's plants. Pioneer has database access for molecular tags in corn genes.	Pioneer to own all gene sequence information and patents to be sought on discoveries.

Monsanto	Incyte Pharmaceuticals	S,E,B	Monsanto has access to Incyte's databases and Synteny's gene expression technology.	Incyte may receive royalties on products developed via agreement.
Monsanto	ArQurle		Working on herbicides, pesticides and fungicides that modulate gene expression.	ArQurle to receive royalties on products developed thru' agreem't
Monsanto/Savia	Mendel Biotechnology	F	Monsanto and Savia each have 20% equity in Mendel, which specialises in exploring the *Arabidopsis* genome.	Monsanto and Savia have rights to products from certain crops, fuit & veg; Mendel has all other rights.
Monsanto	Millenium Pharmaceuticals	S	Creation of new Monsanto subsidiary, Cereon, to identify patentable genes.	Monsanto acquires Millenium's technology for exclusive use in ag.
Monsanto	IBM	B	Both will work on developing computer technologies to map the genetic basis of major diseases affecting plants and humans.	
Monsanto	GeneTrace	F		Monsanto rights to gets exclusive rights to license GeneTrace's techs,
Monsanto	Paradigm Genetics	F,B	Paradigm to analyse products of Monsanto's sequencing and bioinformatics research.	
Novartis	Clemson University Genomics Institute	S,M	To help discover useful genes for crop improvements, pesticides and rice blast.	Data to be made available to scientific community.
Novartis (NADI)	Berkeley's Dept of Plant and Microbial Biology		Novartis funds 30-40% of research and has first rights to negotiate on 30-40% of discoveries. It also reviews manuscripts.	Berkeley owns all patents arising from discoveries made through the collaboration.
Novartis	Diversa	F	Optimisation of economically interesting genes.	
Novartis (NADI)	Myriad Genetics	S	Myriad to work on sequencing cereal crop genomes. NADI and Myriad to jointly offer access to databases they share.	Study results to be made available to scientific community. Novartis owns rights to any discoveries.

Key to type of work: S = sequencing, M = mapping, E = expression, F = functional genomics, B = bioinformatics
Source: Compiled by GRAIN

to economically interesting traits that are controlled by the interaction among a large number of genes. It is therefore unsurprising to find that, as in human genomics research, agroindustrial companies have been eager to claim intellectual property on every gene sequence they stumble across. But unlike the pharmaceutical industry, companies are largely limiting their patent applications to whole genes rather than sequences. As yet, only a few patents have been awarded, but many companies are building up quite a library of patents pending. Companies are unwilling to disclose exactly how many patents they have applied for or have been awarded, but some, such as Pioneer Hi-Bred and Aventis, have been particularly aggressive in this realm. Novartis appears to be favour a more open-access approach to early stage research, but is equally eager to gain proprietary control of anything that looks potentially lucrative (see Table 2).

The practice of patenting human genes and gene sequences has already been denounced by the scientific establishment. Now, interestingly, industry is also starting to question its wisdom. As Steve Seelig, from Vysis, a functional genomics company, recently declared to *Nature Biotechnology*, *"somebody needs to step up and say intellectual property can be an extraordinary hindrance and that patents are not always in the national interest."* Seelig even went so far as to suggest that perhaps the Patent and Trademark Office should outlaw the patenting of genes! Seelig's concerns focused on pharmaceutical research, whose industry serves a global market of US $300 billion. If the pharmaceutical industry is going to struggle to finance genomics research in an aggressive IPR environment, agroindustry will struggle even more, given that the market for agrochemicals and seeds is only one-fifth the size. In practice, the patenting of crop gene sequences could limit the playing field to only those owning enough sequences themselves to gamble with.

Granting property rights on plant gene sequences is already starting to affect the ability of researchers to do their work. A small but significant study in the US found that 48% of 86 university plant breeders who answered a survey indicated that they had experienced difficulty in obtaining genetic stocks from private companies, and 45% indicated that this had interfered with their research. Limiting access to genetic material will have even more serious consequences in the field of genomics than in traditional plant breeding. Sequencing is but the first step in genomics research, and current methods of figuring out the function of the hundreds of thousands of sequences generated in this way require the analysis of many genes at the same time. Such forms of analysis could be prohibitive not only for public sector researchers, but also for many companies if they are forced to pay heavy licensing fees.

There is a certain amount of recognition of this reality amongst researchers, many of whom recognise that it is everybody's interest to keep early stage research findings in the public arena. Competitive advantage would be gained not by being the first to sequence, but by being the first to make sense out of the sequences through the development of proprietary bioinformatics systems. This seems the way many genomics companies, and also some gene giants, such as Novartis, seem to be pushing ahead. As Steve Briggs, head of NADI, says, *"We can't afford to patent everything – our policy is to patent useful inventions."* (As if it should be possible to patent any other kind of invention!)

One aspect that makes functional genomics more straightforward in agricultural research than in pharmaceutical research is the relative homogeneity of plant genes across species. Many companies are able to file for patents on genes in one crop because the function of the same gene has been determined in another crop. How the race for the genes plays out remains to

be seen, but we can be sure of two things. First, companies will do everything possible to ensure legal or biological control of any variety developed through genomics. Second, the farmers that have developed the varieties containing the genes companies are interested in will not be compensated in any way.

Pie in the sky?

Marching boldly into the world of plant genomics is a risky affair for the agricultural industry. The gene giants are failing to recoup the rich rewards they were expecting to gain from the heavy investments they made into transgenic crops. While they confidently boast that consumer adversity to genetically modified crops is merely a storm in a teacup, there is little evidence to suggest that the storm is going to abate any time soon. Genomics research will require unprecedented investments and risks, and has the potential to completely strangle companies and research through legal battles over proprietary issues. Nevertheless, agribusiness seems undeterred, as its substantial investments in this arena over the last few years indicate.

Given that both the agrochemical and pharmaceutical industries are investing so heavily in the genomics approach, the natural progression seems to point towards further consolidation of these two arms of the life industry. But there are also indications that marrying the agrochemical and pharmaceutical industries may not be altogether desirable. The pharmaceutical divisions of the life science giants continue to reap rich profits, but the agrochemical and seed divisions are floundering, owing to a stagnant agrochemical market and growing opposition to genetically modified seeds. Several of the so-called *"life science"* companies are placing their agricultural divisions at arms length. Novartis and AstraZeneca, for example, announced in December 1999 that they would be combining their agribusiness divisions in a new joint venture named 'Syngenta.' Similarly, Monsanto, almost bankrupt from its insatiable urge to gobble up seed companies, has had a hard time courting a pharmaceutical partner.

One thing that is clear is that genomics research can only entertain the élite. The huge costs involved mean that the South can barely even contemplate entering the fray, and Northern public research institutions are finding that they can only participate by prostrating themselves before industry. If the IPR environment continues to tighten up, the number of players will continue to shrink and agricultural research and development will be left in the hands of a few gene giants. Centuries of work by farmers all over the world will be sucked up into proprietary databases and patented gene banks, unavailable for use by all but a handful of researchers, whose goal will be to fill corporate coffers rather than feeding the world.

Even if genomics research was affordable and accessible to farmers, it still wouldn't get them very far because of its limitations. Genomics research is an extension of existing work in genetic engineering. While it does offer the potential to develop crop traits that are dependent on a number of genes instead of just one or two, it is still rooted in a reductionist approach to agriculture. It still totally fails to recognise that gene expression is dependent not only upon the interaction between genes, but also the on interaction between genes *and* the environment. Genomics will merely lead to a refinement of the Green Revolution model of agriculture, which viewed crops as single-function and single-product machines and totally failed to recognise the importance of the agroecosystems surrounding and supporting them. As is clearly demonstrated in the article on vitamin A rice on p 9 of this issue, simply inserting genes coding for desirable traits into crops is going to get us nowhere in addressing hunger and other nutri-

tional issues, and will lead agriculture further and further away from sustainability.

Industry argues that genomics research offers the promise of creating further diversity in agriculture. Even if this is theoretically possible, it will never become a practical reality. Half a century of industrial agriculture has caused agricultural biodiversity to plummet, and there is no reason to believe that genomics is about to change that. All it is likely to amount to is reshuffling an ever-decreasing pack of cards. No matter how many gene combinations to produce a given trait the likes of Monsanto have at their fingertips, they will concentrate their efforts only on the absolute minimum to gain the maximum profit. Industry does not understand the meaning or importance of biodiversity: it is merely interested in genetic resources.

The brave new world of genomics is not the answer to the world's cries for sustainable agriculture: it is only available to large corporate concerns, whose focus is on dollar bills rather than peoples' bellies; it is not accessible to farmers, the real motors for crop research and development; and its reductionist roots mean that research will be kept on a treadmill trying to address the problems it has created in the first place. What is needed is a new approach, which as Dr Mae-Wan Ho says, *"re-affirms the ecological wisdom of traditional indigenous peoples all over the world, who have practised sustainable agriculture on the understanding that the biological nature of each organism or species is inextricably linked to the environment, and depends ultimately on the entire ecosystem consisting of all other organisms."*

The South would be wise to ignore the call of the Green Revolutionaries that point to crop genomics as the way to overcome current limitations of genetic engineering, and push their farmers into the hands of future corporate-controlled, genomics-developed transgenic superplants. Instead, developing countries would be better off to support and learn from the traditional innovation systems developed by their farming communities and indigenous peoples as the foundation for agriculture. Genomics research may provide some important and useful contributions which can be fed into this knowledge system, but to rely on it as the basis for agriculture is complete folly.⌘

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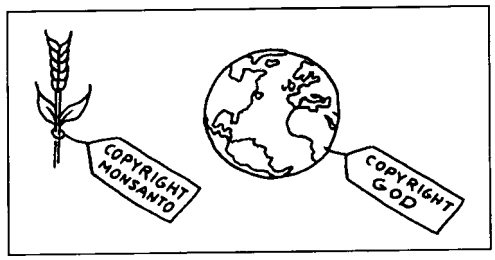


Stan Eales, The Ecologist

Sprouting Up: THE US WAKES UP TO GM FOODS

Genetically modified (GM) foods are now being rejected by farmers and consumers even in their most solid constituency: the heartlands of the USA. The world's largest grower and exporter of GM produce is feeling the effects of a global backlash against GM, and public debate is increasing domestically. As a result, even industry-friendly growers organisations, such as the National Corn Growers Association, have been advising farmers to steer clear of GM crops. The Worldwatch Institute predicts that global acreage of GM crops will fall 25% this year.

US farmers, fearing they will not be able to sell GM products to European and other markets, are retreating in droves from planting GM seeds. Last year market rejection cost them more than $200 million in export revenue. A Reuters poll – conducted early in the planting season at the annual convention of the American Farm Bureau Federation – showed that farmers were already reducing Roundup Ready soybean plantings by 15%, GM maize by 23%, and Bt cotton by 26%.

Some seed companies are discounting their stocks of GM seeds because of lack of demand, and those whose crops have remained GM-free can expect premiums for their products. An added disincentive: farmers who do choose to grow GM crops may be held legally liable for any genetic pollution of the GM-free fields of their neighbours. Farmers associations such as the National Family Farming Coalition and the American Corn Growers are vocal in rejecting GM technology and corporate control of agriculture. Even among loyal customers, farmer resentment is growing against the heavy-handed marketing techniques of the corporations.

It is not just in overseas markets that consumers are rebelling. Though the biotech industry has often invoked those *"rational US consumers making science-based decisions to eat GM foods,"* the reality is US citizens have been kept in the dark about the technology. Virtually all US citizens will have eaten GM food, but a poll by the Pew Research Centre showed that in December 1999 only 22% of them believed they had actually bought GM products. But it seems the more they find out, the less they like it.

In response to consumer fears, the US snack industry giant Frito-Lay has told its suppliers not to grow GM corn. This will put pressure on those companies that have gone GM free in Europe and Asia, but still use GM products in the US. Fast food outlets McDonalds, Burger King, and Wendys have all rejected GM potatoes for their french fries in Europe.

Meanwhile on the stock market, many ag-biotech companies' share prices declined steadily throughout 1999, prompting the Wall Street Journal to pronounce on January 7, 2000, that "*with controversy growing … it's hard to see those companies as a good investment, even in the long term."*

More woes for the industry come in the form of a lawsuit in the US District of Columbia. A group of six farmers on behalf of themselves and others *"similarly situated"* internationally, with the backing of The Foundation on Economic Trends and the National Family Farm Coalition, have filed a class action complaint against Monsanto (and its 'co-conspirators'). They allege that the company is part of a global cartel to monopolise and restrain trade in the GM seed market, and that its rush to market GM foods financially damaged and misled farmers and undermined consumer confidence. The plaintiffs are petitioning the court that GM seeds cease to be sold until Monsanto has *"adequately tested GM seeds and crops for human health and environmental safety, and subjected such tests to independent scientific review and public disclosure."*

The lawsuits don't end there. The case against the US food regulatory body, the Food and Drug Administration, over its 1992 decision to approve GM foods is ongoing, and Greenpeace and 70 other plaintiffs have won the first round of a suit against the Environmental Protection Agency over its authorisation of Bt crops. Campaigns to get GE foods labelled are gathering strength too. In December 1999 the 'GE Food Right to Know' Act went before Congress, and bodies such as the National Farmers Union support the labelling initiative.

Activists like the 'Night-time Gardeners' and 'Reclaim the Seeds' - inspired by European and Asian direct action against GM crops – have destroyed GE crop test sites. Protests, from those in Seattle against the WTO to those in Montreal, Canada during the Biosafety Protocol discussions, have drawn thousands onto the streets. Activists are now gearing up for 'Biodevastation 4' in Boston, USA, at the end of March.

However, the biotech industry is not about to topple. Bill Clinton named January 2000 'National Biotechnology Month', just as a US Senator was touring South East Asia to secure new markets for GM products. Novartis is sponsoring a 'Food to Plate' museum exhibit in Chicago, a science magazine aimed at secondary schools, and distributing 'We Back Biotech' car-license plates, while the Biotechnology Industry Organisation recently advertised on US television with the slogan *"Biotechnology. A big word that means hope."* Although not all PR campaigns are going so smoothly – Monsanto has shelved its multi-million dollar campaign with PR consultants Burson Marstellar after the New York Times reported that the company had paid $25 each for people to take part in a pro-biotech protest outside an FDA hearing.

In short, this is a battle for the minds – and stomachs – of US citizens. How they respond in the coming year will be crucial for the agbiotech industry, which is struggling to survive its most sustained attack yet in the US.

Sources: "Biotech futures," *Multinational Monitor,* Jan/Feb 2000; "Trouble in the garden," *Rachel's Environment and Health Weekly* #685, Feb 3, 2000; various newspaper and email news reports.

INITIATIVES & ACTIONS

CBD/COP5 Related Activity:
The first meeting of the Ad-Hoc working group on Article 8(j) of the Convention on Biological Diversity (CBD), Indigenous and Local Communities Knowledge is being held in Seville, Spain, on March 27–31. Article 8(j) of the CBD addresses the knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity. This meeting preceeds the Fifth Meeting of the Conference of the Parties (COP5) is taking place in Nairobi, Kenya, on May 15-26. Further information, documents and an agenda from:

> **Secretariat of the Convention on Biological Diversity, World Trade Centre, 393 Saint-Jacques St, Suite 300, Montreal, Quebec, Canada, H2Y 1N9. Fax: (1-514) 288-6588, E-mail: secretariat@biodiv.org http://www.biodiv.org/indig**

The regional preparation meeting in Europe for the CBD/COP5 will be held on March 20–23 in in Riga, Latvia.

> **Contact: Conference Secretariat, Ms Ilona Jepsen, Ministry for Environmental Protection and Regional Development, 25 Peldu St, LV-1494, Riga, Latvia, Tel: (371-7) 026 506, Fax: (371-7) 820 442, Email: daba@varam.gov.lv**

The Fourth International Indigenous Forum on Biodiversity will take place in Seville, Spain, on March 24–25.

> **Contact: Patricia Borraz, NGO WATU Acción Indigena/Spanish International Cooperation Agency, Paseo de la Chopera 1, semisótano, 28045 Madrid, España Tel: (34-91) 473 30 31, Fax (34-91) 473 25 01, Email: watu@mad.servicom.es**

Biodevastation 4
Biodevastation 4, the 4th International Grassroots Gathering on Genetic Engineering: 'Resistance and Solutions to the Corporate Monopoly on Power, Food and Life' will take place in Boston, USA on March 25-26. Those involved include activists, scientists, farmers, and concerned people from around the world. Biodevastation 4 will include a teach-in, a rally, and non-violent direct action. A mass protest is planned for March 27, at BIO2000, the USA Biotechnology Industry Organization's largest ever convention, taking place at the same time in Boston.

> **Contacts: Northeast Resistance Against Genetic Engineering Tel: (1-802) 4549957 Email: nerage@sover.net; or Boston Biodevastation: (1-877) 9 737478 Email: biod2000@jamaicaplain.com; more details: briant@earth.goddard.edu**

The Bryansk Declaration
Near the end of 1999, two non-governmental organizations, Viola (Russia) and ASEED (Europe), invited a group of people from Eastern, Central, and Western Europe and the US to meet and discuss genetic engineering. The group issued a declaration, known as the Bryansk declaration. It contains a recognition of common values, including the value of cultural and biological diversity and sustainable agriculture, food security and democracy, and a rejection of genetic engineering and resistance to patenting and corporate control. Contact:

> **The Edmonds Institute, 20319-92nd Avenue West, Edmonds, WA 98020. Tel: (1-425) 7755383, Fax: (1-425) 670 8410 Email: beb@igc.org or from http://www.resistanceisfertile.com/bryansk.htm**

Resistance is Fertile

Another product of the Bryansk meeting was 'Resistance is Fertile', a global week of activities (April 1–10) against genetically engineered foods and to celebrate the diversity of local agriculture. Wherever you are in the world, if you are interesting in co-ordinating local action, be it a public meeting, planting traditional seed varieties, or holding a protest, and would like to co-ordinate it with others globally, get in touch.

> **Contact: info@resistanceisfertile.com or resistanceisfertile@yahoo.com Tel: (44-870) 122 1403 http://www.resistanceisfertile.com**

Organic Agriculture in Cuba

The Organic Agriculture Group of the Cuban Association of Agricultural and Forestry Technicians (ACTAF), in coordination with the Ministry of Agriculture and the National Association of Small Farmers (ANAP), are to hold the IV National Meeting of Organic Agriculture at EXPO-CUBA in Havana, on May 17–19. The meeting will examine the contribution of organic agriculture and agroecology to the transformation of Cuban agriculture towards sustainable rural development.

> **Contact: Marta Pérez Pérez , Executive Secretary, Grupo de Agricultura Orgánica – ACTAF, Apartado Postal 4029 CP 10400, Ciudad de La Habana, Cuba. Tel/Fax: (537) 845387 E-mail: actaf@minag.gov.cu http://www.foodfirst.org**

"Feed the world without poisoning it"

Pesticide Action Network (PAN) is holding its 5th International Conference in Senegal on May 18-21. The Dakar Conference will be organised jointly with an international workshop on IPM and sustainable agriculture under the Regis of PAN Africa. During these events, PAN and partners will exchange information and experiences with the hundred or so participants from all parts of the world, including farmers groups, NGOs, Trade unions, consumer groups, training and research institutions which promote conversion to sound, sustainable and ecological production systems.

> **Contact: Pesticide Action Network (PAN) Africa, BP 15938, Dakar-Fann, Senegal Tel: (221) 825 4914; Fax: (221) 825 1443 Email: panafric@telecomplus.sn**

GFAR2000

An International NGO Workshop on Agricultural Research and Development is being held in Dresden on May 19-20 , to clarify NGO expectations towards the Consultative Group on Agricultural Research (CGIAR) and the Global Forum on Agricultural Research (GFAR). To prepare for this, there is an Agbiodiversity Workshop on May 16-18 for NGOs to prepare a position on agbiodiversity for the International NGO Workshop. There will also be an NGO tent on May 20-24 during the GFAR 2000 meeting.

> **Contact: Susanne Gura, Burghofstr. 116, D-53229 Bonn, Germany. Tel/Fax: (49-228) 485694, Email: s.gura@wunsch.com**

You are what you eat

Five Year Freeze Campaign

RESOURCES & DOCUMENTATION

What happens if you grow a transgenic crop in its original centre of diversity, amidst its wild relatives and the many local varieties developed by farmers over millennia? Greenpeace calls it *genetic pollution,* and warns against its potential disastrous impact, not only for the wild flora but also for the local farmers and their food security. The briefing *Centres of Diversity* first explains what the dangers of unwanted gene flows in centres of diversity are, and then analyses the fascinating past, present and future of a dozen crops. For each crop the briefing examines where it comes from, its cultural significance, who grows it, and in particular, what the genetic engineers are now doing to it. Based on this well researched account, Greenpeace demands a total ban on the import of genetically engineered food commodities into their centres of diversity. Well worth reading.

> **Centres of Diversity: global heritage of crop varieties threatened by genetic pollution, *Greenpeace, Berlin, September 1999. 72 pp. Order from: Greenpeace, Chausseestr. 131, 10115 Berlin, Germany. Email:* ge@diala.greenpeace.org *Web:* http://www.greenpeace.org/~geneng**

Biopatenting and the Threat to Food Security – A Christian and Development Perspective is a report from the International Cooperation for Development and Solidarity on food security and biopatenting, offered to the senior European Commission officials responsible for TRIPs and Food Security. Its key policy recommendations include: all patents on life should be banned; the Convention on Biological Diversity should take precedence over TRIPs; the WTO decision making process should be made equitable and transparent. CIDSE is a network of 15 Catholic NGOs from Europe and North America. They highlight the contradiction between the EU's support of global trade rules that result in the marginalisation and impoverishment of poor famers and communities in the developing world, and the EU's stated development policy to alleviate poverty and promote food security.

> ***Biopatenting and the Threat to Food Security – A Christian and Development Perspective*, International Cooperation for Development and Solidarity, 2000. Order from: CIDSE, rue Stévin 16, B-1000 Brussels, Belgium. Tel: Bob van Dillen (32-2) 233 3751 Fax: (32-2) 230 7082 Email: vandillen@cidse.be Available on website: http://www.cidse.be**

Stolen Harvest: the hijacking of the global food supply is Vandana Shiva's latest book on the globalisation of agriculture and trade. *Stolen Harvest* bears the standard hallmarks of Dr Shiva's work, combining a radical 'big picture' approach with more detailed case studies. Her broad analysis is based on the recognition that much of what we term 'growth' is based on theft from nature and from the poor. She places this in the context of the global economy, seeing bodies such as the WTO and agreements such as TRIPs as the global institutionalisation of this process, and studies the consequences for small farmers, the environment, and our food. *Stolen Harvest* contains many valuable case studies, including investigations into soy imperialism, fish diversity and shrimp farms, and 'mad cows versus sacred cows.' In summary, this is a call for food democracy and a movement for *"the recovery of biodiversity and our intellectual commons."*

Vandana Shiva, *Stolen Harvest: the hijacking of the global food supply,* South End Press, 2000, $14.00, 150pp, ISBN 0-89608-607-0. South End Press, 7 Brookline Street #1, Cambridge MA 02139, USA. To order, check the web: www.lbbs.org/sep/stolen.htm

The Commercial Uses of Biodiversity: access to genetic resources and benefit sharing is a key resource for understanding the implications of the Convention on Biological Diversity on business and research. The book looks at the legal aspects that regulate access to genetic resources and benefit-sharing, and analyses the main industries that make commercial use of genetic resources. Sector by sector the authors look at current status, the participation of private and public sectors, the products based on or derived from genetic resources, the processes of developing a new product, the genetic resources used, how they are selected and how they are accessed, existing instruments for benefit sharing, and provide some very detailed case studies. The study is a two-year project by the Kew Gardens for the European Commission, involving sixteen researchers, who held 300 interviews or conversations with industry and other experts. The result: an impressive amount of information, particularly valuable for the market studies of each of the sectors mentioned above.

Kerry ten Kate and Sarah Laird, *The Commercial Uses of Biodiversity: access to genetic resources and benefit-sharing*, Earthscan, London, 1999, 398 pp, ISBN 1-85383-334-7. Order from: Earthscan Publications Ltd, 120 Pentonville Road, London, N19JN, UK. Fax: (44-171) 278 1142 Email: earthinfo@earthscan.co Web: http://www.earthscan.co.uk/

More than just "*a cartoon book on genetic engineering"*, ASEED's *Of Cabbages and Kings* is a fairly comprehensive booklet on the issues of genetic engineering and its industrial paradigm, and is designed as a campaigning tool for European anti-genetic engineering activists. Its clear, straightforward text is abundantly illustrated with cartoons, some funny, some biting. It gives the low-down on the basic ´who, what, where, when, and how' questions of genetic engineering. It also looks at the significant questions we should be asking about the technology: Who does it benefit? What are the costs? And who will pay for the consequences? Good contents, hard-hitting presentation, many aspects covered, clear language… a tool for action.

Daniel Swartz and Helen Holder (Eds.). *Of Cabbages and Kings: a cartoon book on genetic engineering*, A SEED Europe, Amsterdam, 1999, 91 pp. Order from: ASEED Europe, PO Box 92066, 1090 AB Amsterdam, The Netherlands. Fax: (31 20) 468 2275. Email: biotech@aseeed.antenna.nl

To commemorate the 50th anniversary of the Universal Declaration on Human Rights (November 9, 1998), the World Intellectual Property Organisation (WIPO) published the proceedings of a discussion exploring the relationship between intellectual property rights (IPRs) and human rights. IPRs and human rights are very different, and IPRs are increasingly seen as infringing on fundamental aspects of human rights (eg patenting inventions based on traditional knowledge). The panellists' papers flesh out different angles of this complex situation and raise our understanding of the pros and cons of possible ways forward. However, you won't find any conclusions in this report. As several of the authors stress, whether human rights 'thinking,' much less treaties or institutions, can really influence the direction of intellectual property rights, trade policies or globalisation is a political issue. And at present, governments are letting economic considerations outweigh most others. Anyone who is looking for a snapshot of where human rights and IPR intersect these days will probably get something out of this report

> ***Intellectual Property and Human Rights, a panel discussion to commemorate the 50th Anniversary of the Universal Declaration of Human Rights,* WIPO Publication No. 762(E), Geneva, 1999, 223 pages. ISBN 92-805-0847-4. Available for CHF 20 from WIPO, PO Box 18, CH-1211 Geneva 20, Switzerland. Email: wipo.mail@wipo.int Web: http://www.wipo.int**

In 1999, Finland led the way amongst EU countries when it published a proposed strategy to implement the country's obligations under the Convention on Biological Diversity and the FAO Global Plan of Action. The result is the Finnish Plant Production Inspection Seed Testing Department publication *Landraces in Finland: proposal for varietal research, registration and maintenance system of cereal, forage grass and legume landraces and old commercial cultivars*. The proposal points to both the budgetary lines under the EU's agri-environmental programme and the 1998 changes in European seed marketing legislation – that allow the commercialisation of landraces under certain conditions – in order to build a two-pronged strategy. This involves the establishment of a subsidised system of *on-farm* conservation, complementary to the country's gene bank, and the creation of a register for landraces and old cultivars, according to an adaptation of UPOV criteria. One hopes that other European Union governments follow Finland's lead in addressing the conservation and sustainable use of their countries' genetic heritage.

> **Johanna Onnela, *Landraces in Finland: Proposal for varietal research, registration and maintenance system of cereal, forage grass and legume landraces and old commercial cultivars*, Plant Production Inspection Centre Publications B1 Seeds 1a/99, Loimaa, 1999, 41pp, ISSN 1239-890-X. Priced at US$11.54. Order from: Plant Production Inspection Centre, PO Box 111, FIN-2201 Loimaa. Finland. Fax: (358-2) 7605 6222**

While organic agriculture is growing in the North, it still depends to a great extent on the use of industrial varieties and hybrids. Moreover, breeders intending to serve the specific requirements of organic agriculture find themselves with breeding techniques and germplasm which not only may fail to fulfil such requirements, but in some cases are anathema to them – such as crop genetic engineering. In *Sustainable organic plant breeding*, the Lous Bolk Instituut attempts to fill this gap by presenting a step-by-step plan for the realisation of a sustainable organic plant breeding system based on an alternative concept of plant health. Responding to the concerns of the organic agriculture sector in the North, the report is addressed to the formal organic breeding sector rather than to a farmer-led approach to plant breeding.

> **ET Lammerts van Bueren *et al.*, *Sustainable organic plant breeding. Final report: a vision, choices, consequences and steps.* Louis Bolk Instituut, Diebergen, 1999, 59 pp. Order from (please mention number G24): Louis Bolk Institute, Hoofdstraat 24, NL-3972, LA Driebergen. Fax: (31-343) 515 611. Email: info@louisbolk.nl**

Selling Out: the cost of free trade for India's food security by Devinder Sharma, examines the links between the WTO's Agreement on Agriculture and food insecurity. The study, sponsored by the UK Food Group, highlights the problems of intensive agriculture that are being further aggravated by the process of liberalisation. *Selling Out* looks at the ways in which, as farming is increasingly targeted by big business, the fields of India are being converted from food production to flowers and other cash crops, with potentially catastrophic environment and social effects. It investigates the way TRIPs enable a few multinational corporations to increasingly gain control of India's food supply system. It also provides three case studies on the negative impact of flower cultivation, the erosion of self-reliance

in oilseeds and the impact of bio-patenting on agriculture and biodiversity.

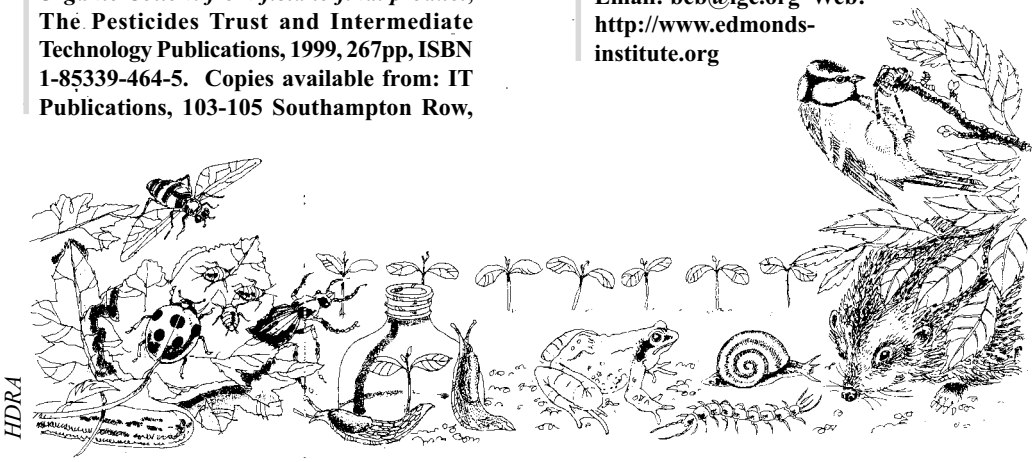
Devinder Sharma, *Selling out; the cost of free trade for India's food security*, UK Food Group, London, Feb 2000, 40pp. Order from: The Ecological Foundation, PO Box 4, Lajpat Nagar-IV, New Delhi-110 024, India. Tel: (91-11) 623 3221. Email: eeg@sdalt.ernet.in

Conventionally grown cotton accounts for almost a quarter of the world pesticide market, yet commercially grown organic cotton is a very recent phenomenon. *Organic Cotton – from Field to Final Product* is a pioneer in this new but growing field where - as yet - little relevant research material exists. It may be particularly valuable in those countries where cotton is a staple crop for small farmers. It gives the first overview of organic cotton production from farmer to consumer. The work begins with an analysis of the negative impacts of conventional cotton growing, and then systematically presents a more sustainable approach, which includes; converting to organic; certification; comparative costs between conventional and organic approaches; and markets for organic cotton. The book demonstrates not just the ecological, but also the financial and social benefits of sustainable cotton-growing.

Eds Dorothy Myers and Sue Stolton, *Organic Cotton: from field to final product*, The Pesticides Trust and Intermediate Technology Publications, 1999, 267pp, ISBN 1-85339-464-5. Copies available from: IT Publications, 103-105 Southampton Row, London WC1B 4HH, UK. Fax: (44 171) 436 2013. Email: katerinas@itpubs.org.uk

Where Nothing is Sacred (The Culture of Commodification), an occasional paper from The Edmonds Institute in the US, is a short, reflective account of some of the key moments in the patents on life debate. For the author Beth Burrows, a conception of the sacred is a central experience of what it means to be human. It is this conception that she sees as fatally missing from the paradigm that dominates in corporate boardrooms and scientific laboratories, where every thing, even the building blocks of life itself, can be split apart and rearranged, bought, sold, and traded. Beth Burrows sadly recalls the biotechnology conference she attended where a panellist referred disparagingly to *"those who would bring ethics and other irrational considerations to the table."* The work is a reminder of the larger ethical framework the patents of life debate should be viewed within. The author concludes, *"Where nothing is sacred, not even life, all may be commodified and sold."*

Beth Burrows, *Where Nothing is Sacred (The Culture of Commodification)*, The Edmonds Institute, 1999, pp24, ISBN 1-930169-11-6. The Edmonds Institute, 20319-92nd Avenue West, Edmonds, Washington 98020, USA. Tel: (1-425) 775 5383 Fax: (1-425) 670 8410 Email: beb@igc.org Web: http://www.edmonds-institute.org



HDRA

GENES ON THE INTERNET

In an effort to increase transparency, the WTO is posting more information about its meetings, and activities on its website, including texts relating to TRIPs and the schedule for negotiations on the Agreement on Agriculture.
http://www.wto.org

Enjoy a visit to the very convincing 'fake' WTO website set up by activist-artists.
http://www.gatt.org/

All theThird World Network's WTO articles written for SUNS are gathered on one web page. Regularly updated, this is essential reading for those following the post-Seattle process:
http://www.twnside.org.sg/title/seattlemain.htm

Focus on the Global South's *Focus on Trade* regular bulletin with clear Southern perspectives and analysis of WTO, UNCTAD and more:
http://www.focus.web

News, reports, and analysis from a variety of organisations on the Seattle WTO meeting and the Biosafety Protocol, with updates, are available at the OneWorld supersite:
http://www.oneworld.net/campaigns/wto
http://www.oneworld.net/campaigns/biosafety/index.html

The Institute for Agriculture and Trade Policy's WTO Watch site offers useful post-Seattle info:
http://www.wtowatch.org/

Public Citizen's Global Trade Watch page contains updates on the WTO, China's entry into the WTO, and provides good information on US attempts to extend NAFTA-like agreements to Africa, the Caribbean, and Latin America:
http://www.citizen.org/pctrade/tradehome.html

Huge amounts of alternative news, including photos, audio, and video, from grassroots radical media in Seattle during the WTO talks, now updated to contain information on new campaigns against the IMF:
http://www.indymedia.org

Worth a quick look simply to get a sense of the levels of worldwide opposition, North and South, to the WTO. As the activists say, *"resistance is as transnational as capital":*
http://www.freespeech.org/inter/world2.html

Genetic ID, a US company providing crop-testing services for non-GMO certification, offers a free newsletter providing an excellent overview of developments in most countries, including updates on labelling news, campaigns, consumer trends, international negotiations, regulations and markets for GM/ non-GM crops:
http://www.genetic-id.com/newsletter/listnews.htm

Fairly comprehensive search for daily headlines on biotechnology issues in global media. Dominated by Northern media and concerns, but with some Asian coverage:
http://fullcoverage.yahoo.com/fc/Science/Biotechnology_and_Genetics/
http://headlines.yahoo.com/Full_Coverage/Science/Genetically_Modified_Food/

The comprehensive version of *The State of the World's Plant Genetic Resources for Food and Agriculture* (510 pages) from the FAO is now available on the Internet in pdf format:
http://web.icppgr.fao.org/pdf/swrfull.pdf

Gregory Aharonian, author and publisher of PATNEWS, has launched a new website focusing on the economics and legal analysis of patents for software/Internet/e-commerce and biotechnology/bioinformatics.
http://www.bustpatents.com

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

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