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EAT UP YOUR VACCINES

GRAIN

Hoping to turn around the debate on genetically modified food, the agbiotech industry is hyping up the second generation of transgenic crops. which bring promises of "functional foods" with tangible consumer benefits. Edible vaccines are being touted as an example of the benefits genetic engineering can bring to the South. Promised to be cheap, accessible and safe, and eliminating the need for the dreaded needle, edible vaccines sound like a dream come true. But the vaccine in a banana is still far from reality, and we will likely all be a lot better off without it anyway.

Not only have the first generation of genetically modified (GM) crops been disappointing in terms of their agronomic and economic returns, they have been a spectacular failure in terms of generating public support for GM foods. In many countries, the spread of GM crops has largely come to a standstill. As a result, the agbiotech industry has changed direction and is hoping to win the public over with its new collection of designer crops. Unlike the first generation, which supposedly delivered benefits for the producer, the second generation crops will – we are promised – be designed with the consumer in mind.

The second generation is focusing on what are known as *"functional foods."* Broadly defined, these are products with a claimed consumer benefit, such as taste, nutritional value, or as a drug delivery system. Functional foods, such as chocolate bars with ginseng, are already widely available in Europe and the US. To date, the extra *"function"* has been added during processing, rather than as a result of genetic manipulation, but this is set to change shortly. All the major agbiotech giants – such as Syngenta (the new Novartis/AstraZeneca agribusiness merger), Monsanto and Aventis – are investing heavily in functional foods. Their agenda is clear. Daniel Vasella, chairman and CEO of Novartis, echoes the hopes of the whole industry in his belief that *"tangible consumer benefits could turn the debate on genetically modified food."*

Some of the more ambitious functional foods in the pipeline are those with pharmaceutical applications. A growing number of companies are starting to engineer plants to produce therapeutic proteins to be used as drugs and vaccines. Up to now, mammalian and microbial cell cultures have been used as *"bioreactors"* to produce these therapeutic proteins, which generate more than $US 18 billion in combined sales per year, a figure projected to increase by 20-30% this decade.

The attraction of plant-based systems is that they exhibit good genetic stability, and are cheaper to develop and easier to scale up for commercial production. The US-based company Epicyte Pharmaceutical has a number of *"plantibodies"* (proprietary technologies for producing antibodies in plants) in clinical development. CropTech corporation is genetically modifying tobacco to produce therapeutic proteins and Large-Scale Biology is working on a non-Hodgkin's lymphoma vaccine. Planet Biology is conducting clinical trials on a monoclonal antibody produced in genetically modified plants that prevents the oral bacterial infection that contributes to tooth decay.

Edible vaccines

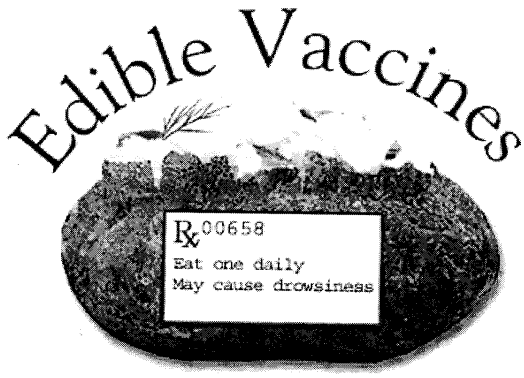
Of all the work on functional foods, research into edible vaccines has captured the public's imagination the most. *"One day children may get immunised by munching on foods instead of enduring shots,"* suggests Scientific American magazine. *"More important, food vaccines might save millions who now die for lack of access to traditional inoculants."* Edible vaccines are the latest, greatest hope of the floundering biotech industry, along with Vitamin A or *"golden"* rice (see *Seedling*, March 2000, p9), to convince a skeptical public that genetic engineering will help the hungry and sick in the South as well as the North. Foods under study as edible vaccines include bananas, potatoes, tomatoes, lettuce, rice, wheat, soybeans and corn. The media has delighted in conjuring up images of African families venturing no further than their garden to pluck a vaccine-laden banana from their homegrown tree to protect them from the major killer diseases of the day. Hoechst's in-house magazine, *Future*, says that *"We may some day think that getting a shot against hepatitis is a rather primitive, old-fashioned way to administer a vaccine."*

The advantages, says Scientific American, *"would be enormous. The plants could be grown locally, and cheaply, using the standard growing methods of a given region. Because many good plants can be regenerated readily, the crops could potentially be produced indefinitely without the growers having to purchase more seeds or plants year after year. Homegrown vaccines would also avoid the logistical and economic problems posed by having to transport traditional preparations over long distances, keeping them cold en route and at their destination. And, being edible, the vaccines would require no syringes – which, aside from costing something, can lead to infections if they become contaminated."*

Medicine's Holy Grail

Vaccination is one of the medical world's greatest success stories. *"Vaccines have accomplished near miracles in the fight against infectious disease,"* proclaims Scientific American. Between 1970 and the late 1990s, an international campaign to immunise all the world's children against six devastating diseases (diptheria, whooping cough, polio, measles, tetanus and tuberculosis) increased the number of infants vaccinated from 5% to about 80%, and reduced the annual death toll from those infections by roughly three million.

But, vaccine proponents argue, the 20% of infants still missed by the six vaccines account for about 2 million unnecessary deaths each year, especially in the most remote and impoverished parts of the globe. Regions harbouring infections that have faded from other areas are like bombs ready to explode, and international travel and trade increase the mobility of infectious diseases. *"Until everyone has routine access to vaccines, no one will be entirely safe,"* warns Scientific American. The World Health Organisation (WHO) has called for new strategies to deliver vaccines to reach the populations that existing programmes have failed to reach. Existing



Environmental News Network

HOW VACCINES WORK

Vaccines work by priming the immune system to swiftly destroy specific disease-causing agents before they can multiply enough to cause symptoms. To date, this priming has been achieved by presenting the immune system with whole viruses or bacteria that have been killed or *"attenuated*" (made too weak to proliferate much). The immune system responds to this vaccine as if it were under attack by a fully potent antagonist and mobilises its forces to destroy the foreign body. Memory cells are then left behind on alert, ready to unleash whole armies of defenders if the real pathogen ever finds its way into the body.

Classic vaccines pose a small risk in that the killed or attenuated microorganism can sometimes spring back to life, causing the disease they were meant to prevent. For this reason, *"subunit"* vaccines (which contain no genes, just proteins derived from them) are now favoured, since they reduce this risk. They are, however, often not as effective as live vaccines. Subunit vaccines are also expensive, because they are produced in cultures of bacteria or animal cells and have to be purified and refrigerated.

Many researchers hope that they will be able to develop edible vaccines which are similar to subunit preparations, containing only the genes coding for certain antigens, not the whole virus or bacterium. One of the main hurdles to be overcome here is that the antigens could be degraded in the stomach before having time to act. (Typical subunit vaccines have to be delivered by injection precisely because of this). Researchers working on an edible hepatitis B vaccine suggest that oral doses may need to be 10-100 times higher than the injectable dose to elicit a comparable immune response.

Source: WH Langridge (2000), "Edible Vaccines," *Scientific American*, September 2000.

vaccines are expensive, need refrigeration and require a skilled person to give the injection – with needles that are hard to come by in some places. Hence the appeal of edible vaccines. But just how realistic or desirable is the dream of the backyard banana?

- **Backyard bounty**

Appealing as it is, reality will probably fall short of the backyard banana tree. *"Our main worry with this technology is the dosage,"* says Bernard Ivanoff, global coordinator for vaccines at the World Health Organization. In determining the right dosage, the patients' weight and age need to be considered, and the size and even ripeness of the banana would also have to be considered. Charles Arntzen, one of the pioneers of edible vaccines, acknowledges the challenge of assessing how much an infant, in particular, ingests. *"A baby may eat a bite and not want any more, may spit up half of it, or eat it all and throw it up later,"* he concedes.

Researchers are now recognising that edible vaccines would be unlikely to make the role of the vaccine provider redundant, and that attempting to concentrate the vaccine into a teaspoon of baby food would be more practical than administering a whole banana. Which begs the question of why bother to engineer it into a banana in the first place?

- **Big task for a banana**

Because heat denatures (inactivates) vaccines, the food material being engineered to produce the vaccine will have to be eaten raw. Many current studies focus on engineering vaccines into potatoes, but it is generally recognised that the potato is unlikely to be a popular or practical vehicle. The potato can attribute its current popularity to the fact that it is easy to engineer. Bananas are being eyed up as the vehicle of choice, particularly for Third World applications, because of their worldwide popularity, abundance and baby-friendliness. But bananas have their own problems. They contain very little protein, so they are unlikely to produce large amounts of recombinant proteins (ie vaccines). Banana trees also take a few years to mature and the fruit spoils fairly rapidly after ripening, making transportation and storage difficult. Researchers at Cornell University at the US have so far been unsuccessful in their attempts to engineer a vaccine into a banana plant. Even if they can be tweaked to produce viable amounts of vaccine, it is well known that plants don't grow very well when they are producing large amounts of foreign protein. The GM potatoes used in Cornell's human trials were small – about the size of a thumb.

- **Transportation**

One of the big draws for edible vaccines is the potential to drastically reduce or eliminate transport costs. But the impracticality of the backyard banana means that the elimination of transport costs is not a realistic option. Some researchers imagine vaccines being produced in national or regional greenhouses, which would be an improvement on flying the vaccines in from overseas, but this could probably better be achieved by establishing a conventional vaccine plant in-country. The environmental and ecological risks posed by edible vaccines (see below) also make it questionable whether many countries in the South should be expected to have the facilities and expertise available to grow the vaccines safely and successfully.

- **Needle-free shots**

Another much-hyped advantage ignores the fact that if they could be given orally, today's vaccines already would be. Few vaccines are absorbed well from the gut because they are too big to cross the gut wall easily and/or are broken down by the gut enzymes. Edible vaccines would be subject to the same limitations as any other oral drugs.

- **Cheap, cheap, cheap?**

One of the key goals of the edible vaccine pioneers is to reduce immunisation costs. The theory goes that edible vaccines would be far cheaper than current injectable vaccines since they would not have to undergo the expensive purification and refrigeration of traditional vaccines, and shipping costs would be much reduced. As we have seen, shipping costs may not necessarily be significantly reduced, and edible vaccines may still require refrigeration. Even if edible vaccines are cheaper, it is not clear that this will lead to increased vaccination

Ecoconsumer

coverage, since the cost of the vaccine is a small part of the whole package. According to WHO, to immunise a child it costs no more than $1 for the big six vaccines, but $14 for programme costs (laboratories, transport, cold chain, personnel and research). For the newer, more expensive vaccines, such as hepatitis B and AIDS, the cost of the vaccine plays a more significant role, but the nature of the vehicle (banana or syringe) will still only represent a small part of the total cost.

- **Will they work?**

Research into edible vaccines is still at a very early stage and they have a long way to go in proving their efficacy. Getting plants to express adequate amounts of the vaccine is proving challenging enough, let alone translating that into an appropriate immunological response in people. Producing stable and reliable amounts of vaccines in plants is complicated by the fact that tomatoes and bananas don't come in standard sizes. There may also be side effects due to the interaction between the vaccine and the vehicle. In many countries in the South, stringent quality control standards for standard drugs are quite a luxury, let alone dealing with the added complications posed by edible vaccines. People could ingest too much of the vaccine, which could be toxic, or too little – which could lead to disease outbreaks among populations believed to be immune.

Oral vaccines are also more difficult to formulate than injectables – for example, the oral polio vaccine is more convenient but less effective than the injectable one. The vaccines are likely to need cofactors (adjuvants) such as cholera toxin to enhance their uptake and increase their effectiveness. In addition, new vaccines have to be tested worldwide, since their effectiveness is not uniform in different contexts. When the tuberculosis vaccine (BCG) was tested in the UK, it proved to be effective. But it did not work in India, probably because tuberculosis is linked to nutritional status.

- **Environmental and health risks**

Over the last two decades, there has been a dramatic increase in outbreaks of new and re-emerging infectious diseases. One of the factors implicated in this phenomenon is the transfer of genes across unrelated species of animals and plants. This *"horizontal gene transfer"* has been pinpointed as being responsible for the new bacterial strains involved in the cholera outbreak in India in 1992 and the *Streptococcus* epidemic in the UK in 1993. Antibiotics and traditional vaccines already contribute to horizontal gene transfer. Recombinant vaccines, like those that would be used in edible vaccines, would exacerbate such transfer. This is a serious concern for the release of any genetically manipulated organism, but particularly worrisome in the case of vaccines, because of their disease-causing potential.

The ecological and environmental risks of edible vaccines seem to have received little attention, despite the fact that they present major hazards (see box). Containing these risks, assuming they are taken seriously, would certainly eliminate the possibility of the backyard banana, and greenhouse facilities would need to be rigidly controlled. The risks associated with edible vaccines are particularly worrisome given the medical community's blind faith in vaccination in general and its seeming unwillingness to take seriously evidence that has been accumulating related to vaccine safety (such as the rise of autoimmune diseases).

Regulators are trying to figure out how to deal with plants engineered to produce drugs. Some safeguards are already in place. In the US, all field tests of drug-producing plants require government permits, while some field tests of other modified crops require only notification

GENES GOING WILD

Genetic engineering is inherently hazardous because it depends on developing gene transfer vectors (carriers) specifically designed to cross wide species barriers. It promotes the transfer of genes *horizontally* across species, instead of *vertically* within species by inheritance. It is also increasingly designed to overcome the species' defence mechanisms which degrade or inactivate foreign genes. It is still a very crude science, with genes being inserted at random points in the host's genetic material (genome), rather than being carefully pinpointed as happens in traditional breeding. For these and other reasons, genetic engineering destabilises the genomes of its plant and animal hosts, and the effects ricochet through the neighbouring ecosystem. There is growing evidence that by facilitating horizontal gene transfer and recombination, genetic engineering may be contributing to the emergence and re-emergence of infectious, drug-resistant diseases. Edible vaccines (even subunit vaccines) will always entail the ingestion of recombinant viral genetic material, and hence pose considerable risks to the environment and health.

Edible subunit vaccines are likely to be less dangerous than those that may be produced using genetically modified viruses and viruses used as vectors (carriers) for the vaccine. But they still involve the insertion of foreign genes into the plants and the implications thereof. Genetically tweaking the pathogen to reduce its potency is even more risky. It has been demonstrated that minor genetic changes in, or differences between, viruses can result in dramatic changes in host spectrum and disease-causing potentials. According to Terje Traavik of the Norwegian Institute of Gene Ecology, *"For all these vaccines, important questions concerning effects on species other than the targeted one are left unanswered so far."* There are also considerable risks related to the possibility of a genetically engineered vaccine virus engaging in recombinations with naturally-occurring relatives. New viruses resulting from such events *"may have totally unpredictable characteristics with regard to host preferences and disease-causing potential,"* says Traavik.

Naked DNA vaccines, which comprise the genes of the pathogen without the virus *"shell,"* are perhaps the most risky. These short pieces of DNA are readily taken up by cells of all species, and may become integrated into the cell's genetic material. Unlike chemical pollutants which dilute out and degrade over time, these small DNA fragments can be taken up by cells and multiply and mutate indefinitely. They are known to have significant and harmful biological effects including cancers in mammals. Upon release or escape to the wrong place at the wrong time, horizontal gene transfer with unpredictable biological and ecological effects is a very serious, and as yet unregulated, hazard.

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of the relevant government body. For no particular sound scientific reason, the required distance by which the drug-bearing plants must be isolated from other plants to prevent cross pollination has been set at double the usual distance. But, as with releases of all genetically modified organisms, the parameters considered in determining a product's *"safety"* are extremely limited, and do not inspire confidence in dealing with the many and varied risks associated with edible vaccines.

Vaccine movers and shakers

Much research on edible vaccines is being undertaken in the public sector at present (see box on p9). The industry is eager to hype up the benefits of edible vaccines to win over support for genetic engineering, but this seems to be more of a public relations exercise than real commitment. As indicated by the roster of patent applications on edible vaccines(see table on p 10), most industry research is being undertaken by small technology companies, rather than the big vaccine producers. A few large companies, like Mycogen (Dow Agrosciences) are looking into edible vaccines, but are more interested in the livestock market than human application.

University of Cornell's Charles Arntzen, who first pioneered the idea of edible vaccines, says he has had little success in selling the idea of edible vaccines to the big vaccine producers. He sees two main reasons for this – firstly, his main focus has been on vaccines for the South, such as diarrhoeal vaccines, which are not seen as a good investment by the companies. Secondly, they *"have the market sewn up with traditional injections."* Arntzen believes that a small vaccine start-up will have to lead the way in proving the viability of the technology, and that the big companies will follow.

Historically, profit margins in vaccine markets have been low as compared to pharmaceutical markets primarily due to the non-proprietary nature of common vaccines. In the 1970s and 1980s innovation was slowed by the paucity of resources and competition in this area, primarily due to concerns of liability and commercial viability. In the US, legislation in the last ten years that removed liability from companies except in relation to manufacturing defects has encouraged re-entry into the market. Vaccine companies are reaping bigger profits again. The world vaccine market was estimated to be $3.6 billion in 1999 and is growing at 12% annually. The market is highly concentrated, with three pharmaceutical giants (SmithKline Beecham, Aventis [which has swallowed up both Merck and Pasteur Connaught Merieux] and Wyeth Lederle) accounting for more than 75% of sales.

The advent of recombinant vaccines, which are being developed against malaria, AIDS and hepatitis B, means that vaccines are no longer necessarily cheap. When it first came on the market in the US, the hepatitis B vaccine cost $150 a shot. Although the price has now come down to $1, it is still well out of the range of affordability in developing countries. Some researchers point to these new recombinant vaccines as possible candidates for edible vaccines: the injectable vaccines against diptheria, tetanus, pertussis, and so on are so cheap now that there would be little incentive to develop edible vaccines for them. But it is just these technologies that the corporations would be hugging tightly to their chests for as long as their patents will allow.

Vaccine companies are only interested in developing vaccines that will sell in the North. As HIV vaccine developer Stanley Plotkin of Aventis Pasteur explains, *"The keystone of the [global vaccination] system is that the research costs are recouped in North America and Europe, and the vaccines are sold in the developing world at much, much lower*

WHO IS DOING WHAT WITH EDIBLE VACCINES?

- The first human clinical trial of an edible vaccine took place in 1997, when volunteers ate raw potatoes genetically engineered against diarrhoea-causing *E coli*. Ten of the 11 volunteers who received the vaccine had fourfold rises in serum antibodies.

- Researchers from the Boyce Thompson Institute (BTI) at Cornell University conducted another clinical trial of an edible vaccine in 1999. Potatoes containing the Norwalk virus (which causes vomiting and diarrhoea) fed to volunteers elicited an immune response in 19 out of 20 subjects. BTI researchers are attempting to engineer vaccines into bananas and have produced powdered tomatoes that carry Norwalk virus DNA. BTI scientists have also been awarded a Rockefeller Foundation grant - $58,000 for three years - to collaborate with Mexican researchers at the Mexican health agency, CINESTAV.

- Prodigene and Stauffer Seeds (a spin-off of Staffer Chemical, formerly a division of Novartis) have conducted clinical trials on pigs using an edible vaccine for transmissible gastroenteritis virus (TGEV) expressed in corn, and are developing a Hepatitis B vaccine for humans.

- The US' Large Scale Biology Corporation is developing a patient-specific non-Hodgkin's lymphoma vaccine in plants. Current methods for making the custom vaccine require up to a year to produce vaccine for patient use; LSB thinks its production process could reduce that time to 6-8 weeks.

- Under license from Mycogen, the UK's Axis Genetics was developing an oral hepatitis B booster vaccine in edible plants, and had plans for Norwalk virus and diarrhoea. Axis went out of business in 2000, saying that protests over bioengineered food had scared off investors. Myocgen continues to work on edible vaccines for animals.

- Under license from Groupe Limagrain, Meristem Therapeutics has developed industrial processes for the large-scale production of recombinant therapeutic proteins in plants. Plants including tobacco, corn, potato and rape seed are being used as bioreactors for the production of enzymes, antibodies, and vaccines.

- The Scripps Research Institute is working on an edible HIV vaccine. Initial success has been reported in splicing amino acids from HIV into the cowpea mosaic virus (CPMV). When inoculated with CPMV, cowpea plants reproduce HIV.

- Scientists in Poland working with the US' Thomas Jefferson University have tested a hepatitis B vaccine contained in lettuce on human subjects.

- In Melbourne, Australia, CSIRO has grown a measles-fighting tobacco plant and has begun pilot studies with oral plant-based vaccines for malaria and HIV.

Select patents on edible vaccine technologies

PATENT HOLDER	CLAIM
Ribozyme-Pharm	Nucleic acid vaccine used to treat or prevent viral infections in plants, animals or bacteria
Found. Advan. Mil. Med (USA)	Antibacterial vaccine expressed in plant cells, particularly useful against shigellosis
University Loma Linda	Gene constructs used to produce edible vaccines to treat autoimmune diseases, including diabetes and multiple sclerosis
Rubicon-Lab	Retrovirus expressed in animal or plant cells useful as virus and cancer vaccine
Biosource (now Large Scale Biology)	Plant viral vector with potential as anti-AIDS vaccine; recombinant proteins for use in vaccines to protect against parasitic infection, eg malaria
Applied Phytologics	Gene constructs for disease resistance, vaccine production in rice, barley, wheat, corn
University of Texas	Hepatitis B virus core antigen recombinant vaccine
University of Yale	Vaccine against invertebrates (insects, arachnids, helminths, etc)
Biocem; Rhone-Merieux	Rabies vaccine in transgenic plants
Institute Pasteur	Attenuated *E coli* vaccine for use in gene therapy
University of Texas A&M/ Tulane University	Transgenic plants containing *E coli* enterotoxin B for edible vaccine application in animals
USDA/Univ. Philadelphia	Rabies vaccine expressed in tomato plant
Cornell University	Increasing foreign protein expression
Scripps Research Institute	Recombinant antigen production in lettuce, spinach, tobacco, kidney bean, or *Chenopodium amaranticolor*
Prodigene	Recombinant antigen production and transfer to plants cells using plasmid vector system; Transmissible Gastroenteritis Virus in tomato and potato; broad patent for edible vaccine technology in all plants
Mycogen/Washington Uni.	Series of broad patents covering plant-based edible vaccine tech.
Agr.Genet/Purdue Research Foundation	Modified viruses used for vaccine production in plants, esp. against food and mouth disease, HIV and human rhino virus

Source: Compiled by GRAIN from Derwent Technology Abstracts, October 2000

margins." Hence, very little research is undertaken on diseases that have no market in the North. According to the World Bank, funds for global public and non-profit malaria research in 1993 totalled about $84 million, with only a small part of that devoted to vaccine research. The amount of private sector spending is *"generally considered to be even smaller."* Because of this, the World Bank is looking into setting up a $1 billion fund to help countries purchase vaccines. Such a fund could *"ensure that there would be a market for malaria, tuberculosis or AIDS vaccines if they were developed, and thus would create incentives for vaccine research."*

How effective the establishment of such a fund would be in stimulating research in the industry remains to be seen, but it would no doubt be welcomed by the agencies involved in vaccination programmes in the South, such as UNICEF and the WHO. In terms of the potential fof edible vaccines, the WHO is cautiously optimistic. According to the WHO's Uli Fruth, *"WHO is very interested in technologies which (a) may render vaccines more affordable for use in developing countries, (b) which may allow future vaccine production in developing countries and (c) can be delivered needle-free. All three conditions appear to be fulfilled in this case."* WHO is not investing heavily in edible vaccine research, but has provided some seed-funding (Arntzen's work on edible vaccines at Cornell) to help establish proof of principle. Fruth acknowledges that before endorsing such vaccines for human use, WHO's concerns related to quality assurance, efficacy and environmental impact will need to be addressed in a satisfactory fashion. But if the WHO's position on GM foods is anything to go by, its approach to safety issues is unlikely to very wide-reaching or reassuring. A joint WHO/FAO consultation on the safety of GM foods recently concluded that *"the pre-marketing safety assessment [of GM foods] already gives assurance that the food is as safe as its conventional counterparts."*

Just a pipe dream?

Despite their willingness to throw out edible vaccines as an example of the benefits of GM foods, the pharmaceutical and agbiotech industries seem to be merely tinkering with the idea at the moment, and are not investing heavily in research. A few small biotech companies and university departments are pioneering the way. It is possible that in time they may convince the corporate giants to let go of their established technology and invest in edible vaccines, but this seems unlikely given the complexity of the challenge of creating a safe, convenient and affordable product. People all over the world can breath a big sigh of relief (at least for now), given the serious risks that edible vaccines pose. As Norway's biosafety expert Terje Traavik has pointed out, *"There is a most striking lack of holistic and ecological thinking with regard to vaccine risks. This seems to be symptomatic of the real lack of touch between research in medicine and molecular biology on one hand, and potential ecological and environmental effects of these activities on the other."*

The potential for harm that edible vaccines pose highlights the need for thorough and wide-reaching risk assessments for GMO releases. Current frameworks for regulation are woefully inadequate. In addition, researchers and policy makers need to examine closely the whole field of infectious diseases. There are other ways of preventing the spread of infections diseases (such as breaking transmission chains) and these must be given greater attention instead of focusing solely on the technofix solution of vaccination. This does not necessarily mean abandoning vaccination altogether, but developing a more holistic approach to the management of infectious diseases.

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Brot fur die Welt

TRADE AND HUNGER

JOHN MADELEY

Here we offer some extracts from a new survey examining the relationship between trade and food security, poverty and the environment. "Trade and Hunger" distills the findings from 27 impact assessments on the effects of trade liberalisation from 39 countries in Africa, Asia, Latin America and Eastern Europe. The consistent conclusion from these studies is that so-called "free trade" as promoted by the World Trade Organisation benefits only the rich, while making the poor more vulnerable to food insecurity.

Trade liberalisation (the removal or reduction of barriers to international trade in goods and services) has become a global prescription for the world's continued economic growth and universal prosperity. But accumulating evidence on the relationship between trade liberalisation and food security and poverty suggests that there will be more losers than winners. This study examines this liberalisation under the World Trade Organisation's (WTO) Agreement on Agriculture (AoA) signed in 1994; under World Bank/International Monetary Fund-imposed structural adjustment programmes (SAPs), which have been going on since 1980 (and which led to widespread liberalisation of the economies of most developing countries well before 1994), and under regional free trade agreements.

Under SAPs and AoA, developing countries have to make significant changes in their food and agriculture policies. They are obliged to open up their economies to cheap food imports and to reduce and severely limit support for their farmers. Most SAPs require more sweeping liberalisation measures than are required under the AoA, and also demand related measures such as privatisation of state-run enterprises, the elimination of subsidies and price controls, and the abolition of marketing boards. By contrast, the AoA centres on trade liberalisation measures – it calls, for examples, on member countries of the WTO to reduce tariffs on food imports by 24% over a ten-year period. The 48 least developed countries are excluded from this and from other reduction commitments. The AoA – a deal largely stitched up by the United States (US) and the European Union (EU) under pressure from business corporations – tightens the screw of structural adjustment. Oxfam has referred to the AoA as an *"act of fraud"* that will give rise to increased competition from imports and intensify rural poverty and destroy smallholder livelihoods. And unlike SAPs, the AoA is binding on member countries of the WTO, which number some 137 as of July 2000.

According to the study, trade liberalisation is failing the poor in a number of different ways:

1) Cheap imports

The majority of people in developing countries belong to farming families. Most farmers are small-scale, with at best a few hectares of land and sometimes much less. The problems for these farmers caused by cheap imports, made possible by trade liberalisation, comes across in most of the case studies. Cheap imports orignate from both developed countries (especially the United States and the European Union and also from developing countries (imports of sugar into the Philippines from Thailand, for example).

Competition from cheap imports is putting farmers in developing countries out of business. Such imports are coming both through commercial channels and through dumping – food sold below the cost of production to dispose of surpluses, and usually cheaper than commercial imports and more damaging. Ghana provides just one of many examples of how food imports have demoralised small-scale farmers. Having produced corn, rice, soybeans, rabbit, sheep and goats, the farmers cannot obtain economic prices for them, even in village markets. Their produce cannot compete with cheaper imports. Domestic food production is threatened as the agricultural sector is placed in jeopardy.

The studies show that liberalisation has led to an increase in the prices of farm inputs, causing huge problems for small farmers. Forced to pay more for their inputs, they are often receiving less for their produce when they come to sell. In economic terms, trade liberalisation appears to have worsened the terms of trade between outputs and inputs. Harvested food prices have not always fallen (see box). According to the studies, higher food prices as the result of trade liberalisation would appear to be the exception.

Consumers may appear to gain from cheap food imports. But they only do so if they have the money to buy, which many people in developing countries don't have. And cheap food imports damage the livelihoods of small-scale farmers and also the countries' most basic economic sector – its food-producing sector. Also, if trade liberalisation gives more power to monopolies, consumers eventually stand to pay higher prices.

2) More priority for export crops

Trade liberalisation means more food imports; often it reduces the priority that governments give to their food crop sector, while increasing the priority they accord to crops for export. Many of the studies show that trade

MADAGASCAR: WHEN GROWTH IS NOT GOOD

Agricultural policy reforms in Madagascar seem to have hurt the rural poor despite the increase in their output. Following reform, agriculture grew the fastest it had in 20 years (albeit still at a modest rate), with growth concentrated among the smallest farmers. But the evidence also shows deepening poverty during and following liberalisation, particularly in rural areas. Nutritional, educational and spending data all suggest significant deterioration in living standards among the country's primarily rural poor. An important cause appears to be the significant liberalisation-induced rise in all the major crop prices, particularly rice.

Rice price changes, associated with liberalisation, are estimated to have led to losses of more than 20% for more than a third of the country's rice farmers who comprise most of the country's poor. Because most small farmers in Madagascar are net rice buyers, liberalisation seems to have induced significant welfare losses among the country's primarily rural poor, including a large proportion of rice producers. A natural response for immiserised smallholders is to increase their labour effort to increase output. Hence the apparent paradoxical result of higher agricultural output and higher rural poverty.

*Source: T*he World Bank's World Development Report 2000

liberalisation has led to more land and resources being devoted to export crops and less to domestic food production. In Benin, for example, government incentives led to an increase in land under cotton; cotton exports have increased to the detriment of food production and food security.

Although governments are generally according more priority to the export crop sector, this does not necessarily mean that farmers are receiving better prices for these crops. World prices for many are declining – as witnessed in case studies on Kenya, Sierra Leone and Uganda. As traders, and not government bodies, are mostly buying these crops, the price they offer the farmer will be related, in some degree, to the world price. But the power of the traders may mean that the price to farmers is far below the world price.

3) Transnational corporations (TNCs)

Trade liberalisation is proving very beneficial to large entities such as TNCs – as seen in the studies on India, Philippines, Uruguay and Cambodia. But it is not just proving beneficial to them, it also appears to be helping them at the expense of the poor. The Food and Agriculture Organisation (FAO) notes that the process is leading to the concentrations of farms *"in a wide cross-section of countries"* and to the marginalisation of small producers, adding to unemployment and poverty. In Mexico, the winners from trade liberalisation are concentrated in the country's fruit and vegetable growing areas where production is predominantly on large-scale, irrigated farms. There is a *"dramatic increase in investment in these areas, with large farms or firms leasing land."* This finding is consistent with an emerging global pattern of increased profits for transnational corporations at the expense of poorer producers.

4) Landlessness

In Cambodia, more land has been bought and sold, leaving farmers with not enough or no land. Ten years since the adoption of the liberal market economy in 1989, it is estimated that 10-15% of the country's farmers are landless and that land is being concentrated in fewer hands. The top 10% of the population own 33% of cultivated land while the bottom 20% own less than 4% of cultivated land.

5) Women

The studies on Kenya, Ghana, Uganda, Zimbabwe, Mexico, Jamaica and the Philippines all show how trade liberalisation is impacting heavily on women and accentuating gender inequality. In Uganda, liberalisation may mean that the local parastatal depot is closed down, and producers have to go out of the village to a local market to sell their produce. Failing to do this will oblige them to sell their produce to village grader who will benefit at their expense. Women are often faced with a very heavy workload which gives them little time to go to the local market to sell their produce. If they sell their produce in the village, they will get lower prices.

Women, who produce 60-75% of food in most African countries, have been affected disproportionately by the elimination of subsidies, the drying up of credit and the surge of food import as a result of trade liberalisation. Women have the responsibility for putting food on the family table; but prices of farm inputs have risen under liberalisation, and incomes of farming families have come under serious pressure. As a result, many have been forced to cut back on the quality and frequency of their meals. Life in Zimbabwe, notes one study, is becoming a nightmare, with everyone in the family crying out for food.

In Mexico, male labour migration increases the workload on women and children, who are often withdrawn from school. There has been a sharp increase in the frequency with which women are forced to migrate in search of work as day labourers: they now comprise one third of this workforce. *"To the extent that liberalisation accelerates these trends, it will exacerbate problems of inequality and rural poverty,"* notes the Mexican case study.

Trade liberalisation can have positive effects – by enabling rural women to engage in micro and small enterprises in Kenya, for example. But the studies indicate that the negative effects far outweigh the positive.

6) Unemployment

There are no worldwide figures as to how many people have lost their jobs as a result of trade liberalisation over the last 20 years. In Mexico, 700,000 - 800,000 livelihoods will be lost as corn prices fall, representing 15% of the economically active population in agriculture. In India, the jobs of 3 million edible oil processors were lost. In Sri Lanka, 300,000 jobs were lost following the drop in production of onions and potatoes. Globally, it would not be unreasonable to estimate a figure of at least 30 million jobs lost in developing countries because of trade liberalisation and related factors.

7) Environment

The cultivation of cash crops for export imposes considerable environmental costs. In the Philippines (and numerous other countries), the extensive use of agrochemicals in export-crop production has increased soil degradation and the loss of biodiversity. Liberalisation encourages producers to abandon traditional and ecologically sound agricultural practices in favour of export monocropping. Also, the encouragement of agri-based exports in special development zones creates massive colonisation of critical watersheds and the depletion of water resources in irrigated areas, previously planted to food crops.

8) Government services

Under SAPs, liberalisation goes hand in hand with a reduction in government support for farmers, such as investment in agricultural research and extension, controlled pricing and marketing, and subsidies on inputs. Governments withdraw and leave people to the free play of economic forces. People with money may survive, but the poor are left stranded. The Philippines is probably typical in that insufficient state support for services such as irrigation, post-harvest facilities and farm-to-market roads has meant that small-scale farmers are unable to improve productivity levels or get their products to market at prices that cover costs.

9) Self-sufficiency and sovereignty

The negative impact of trade liberalisation on food self-sufficiency, let alone food sovereignty, comes across in many of the studies. The effect of free trade on India's edible oils sector is startling. Tariff reductions allowing massive imports turned India from being self-sufficient in edible oils to being the world's largest importer in a mere five years (see box).

10) Traders gain

In a number of countries, the liberalisation of markets has increase participation by private firms and individuals in the trade of food commodities, unlike in the past when public institutions dominated the trade. In theory, this could lead to increased employment opportunities, which would be a positive move. But this does not seem to be happening. Liberalisation has certainly increased the

INDIA: SOYBEAN'S RISE AND FALL

In the 1980s and early 1990s, government initiatives in India led to what seemed the impossible: self-sufficiency in edible oils in the span of a decade. The star of this impressive performance was a relatively new crop for India – soybean. In 1980-81, India produced 0.4 million tonnes of soybean; in 1998-99, production peaked at 6.2 million tonnes, making the country the fifth largest producer after the US, Brazil, Argentina and China. The share of soybean in total oilseeds production in India rose from 5% in 1980 to 20% in 1994. Significantly, unlike in the case of rice and wheat under the Green Revolution where most of the gains went to better-off farmers, soybean cultivation was uniquely suited to dryland conditions and was largely undertaken by small and marginal farmers in these areas.

So much for the good news. Production is expected to be sharply lower in 1999-2000 at around 5.2 million tonnes, with acreage declining by some 12%. Following a series of recent policy changes, many soybean farmers have felt they have no choice but to switch to other crops. The sharp reduction in import tariffs on edible oils from 65% to 15% between 1995 and 1998 drastically reduced the level of protection enjoyed by Indian oilseed farmers. Non-tariff restrictions on the import of edible oils were also lifted. These sharp reductions were not entirely mandated by the WTO's AoA. India's commitments to the WTO allowed it to maintain a tariff of 45%. Large scale imports of edible oil in 1998-99 depressed prices for domestic edible oil. From attaining self-sufficiency in edible oils, India had come full circle to become the world's largest importer.

Indian farmers are having to pay more and more for their inputs while receiving less for their crop. High seed prices, following the failure of government bodies like the National Seeds Corporation to provide good quality seeds at the right time, have left the door open to private seed companies – a move which has also hurt farmers. In 1999, farmers near Indore were reportedly losing more than Rs 1,300 (US$ 30) per hectare of soybean cultivated. Apart from farmers, the whole edible oil industry has obviously been affected. The solvent extraction industry, which is largely dependent on the extraction of oil and meal from soybean, currently operates at about 30% of capacity. One estimate suggests that the livelihoods of at least 3 million people have been destroyed as the result of policy changes related to edible oil production.

Source: Binu S Thomas, Action Aid, India, 1999

number and power of traders. In Uganda, for example, traders have *"invaded"* whole villages and used their bargaining power and the need of farmers for cash (to buy inputs for example), to buy harvested crops at low prices. This puts more pressure on farmers and endangers household food security.

11) Migration

When trade barriers are lowered, many small-scale farmers are unable to compete with cheaper imports and leave their land to head for the cities and towns, adding to pressures on urban services.

12) Indirect effects

A number of studies show how changes in economic sectors, other than agriculture, have an impact on food security. In Kenya, the liberalisation of textiles and footwear has led to imports flooding the domestic market. *"This has led to a drastic decline in the production of cotton and, as a result, a loss of income to cotton producers, exacerbating the problem of food insecurity for most households in rural and urban areas,"* says one study. In the Philippines, financial liberalisation has resulted in higher interest rates, lower investments, and higher costs for food inventories and stockpiling. These effects foster instability in the market for staple foods and threaten the food entitlements of the poor.

Conclusion

As the author of the Thailand study says, *"Many of us have been saying for a long time that unchecked, liberalised global trade is a disaster waiting to happen. No one listened. Now it's happened."* Small-scale farmers are bearing the brunt of this disaster. But consumers too are vulnerable. In free trade theory, production will allocate to where costs are low and consumers – poor as well as rich – will benefit from low prices. The reality is more complicated, however. If trade liberalisation gives more power to monopolies, then consumers eventually stand to lose.

Much of the trade liberalisation of the last two decades has been based on the hope that agricultural production in developing countries will switch to high-value crops for export, enabling them to import food. But trade liberalisation in Sierra Leone did not lead to the hoped-for benefits from exports of cocoa on coffee. Ethiopia and Bangladesh have experienced problems in trying to meet food security needs through exports. Agriculture is the main source of livelihood for hundreds of millions of people in developing countries. If small-scale farmers are out-competed without an alternative source of livelihood, the availability of cheap imports is no help. Governments seem to be misled or pressurised to subscribe to trade liberalisation, or to do it too quickly, without adequate preparation.

Trade liberalisation is only one factor exacerbating problems for the poor in many countries. The studies often reveal the interaction of factors that affect food security, such as privatisation; domestic, economic, and financial policies; and the incidence of HIV/AIDS. As the study on Thailand points out, *"the mess isn't simple;"* devastating weather patterns, massive unemployment, the need to earn foreign exchange *"to bail out an unbelievably irresponsible private sector"* are all factors. But these studies indicate that trade-based food security for the poor is – at least for the time being – more a mirage than a fact.

Yet liberalisation is a policy choice, it is not inevitable. A fundamental review of the dominating policy paradigm is needed, and at the very least, WTO rules need to be changed so that developing countries can provide domestic support and other regulations to protect the livelihoods of smallholders and promote food security.

"Trade and Hunger – an overview of case studies on the impact of trade liberalisation on food security" was compiled by John Madeley for Church of Sweden Aid, Diakonia, Forum Syd, the Swedish Society for Nature Conservation and the Programme of Global Studies. It is available from Forum Syd, Box 15407, 104 65 Stockholm, Sweden. Tel: (46-8) 506 370 00, Fax: (46-8) 506 370 99, email: <forum.syd@forumsyd.se> It can also be downloaded in PDF format from Forum Syd's website at: http://www.forumsyd.se

POTATO, THE NEW GLOBAL TRAVELLER

GRAIN

Until recently, the potato largely fed domestic markets. But the meteoric rise of the fast-food industry is increasing global demand and turning the potato into a big export commodity for the seed companies. This follow-up to the article in the last Seedling, which focused on efforts to increase potato production in the South, examines the fate of the potato in the North: who is controlling the markets, who is shaping the direction of research and development, and who is reaping the profits.

Over the last 30 years, the spectacular rise of the fast-food and processed food markets has come to dominate patterns of potato growing in Western Europe, the US and Canada. The share of the crop destined for fresh consumption has been decreasing steadily, and now stands at 26% in the US, 18.5% in the Netherlands, and a mere 2% in Flanders, Belgium. Instead, potatoes are destined to become pre-cooked frozen french fries or potato chips. Alternatively, they may be dehydrated, canned or used to produce flour or starch for an increasing number of industrial applications.

In 1998, 90% of frozen fries in the US were sold by fast food outlets. The market is extremely concentrated, with only three companies (J.R. Simplot [a major supplier of the main french fry outlet, McDonald's], McCain Foods and Lamb Weston [owned by food giant ConAgra]) accounting for almost the entire North American market. This concentration grants potato processors a high degree of control over the crop, and forces potato farmers in the vulnerable position of being contract growers. The processor contracts farmers to grow given varieties under given conditions, and a price for the harvest is set before the season begins. This is a high-risk strategy for farmers because the crop is highly prone to disease and reliant on the use of agrochemicals (see "Potato: a Fragile Gift from the Andes", *Seedling* September 2000, Vol. 17, No 3). In Europe supermarkets are extending contract growing to table potatoes as well as those destined for processing.

Parallel breeding strategies

The sustained growth of the potato processing sector has attracted the efforts of potato breeders. Their priorities have included building resistance against pests, diseases and abiotic stress on one hand, and fulfilling industry quality requirements (tuber size and shape, dry matter and sugar content, sensitivity to cold, discolouration and bruising, and starch structure) on the other.

The similar patterns which have emerged in Western Europe and North America in terms of breeding goals, industry-led production and contract growing have converged from very different breeding strategies in the two continents. While in Western Europe potato breeding has been the concern of the private sector, in the US the public sector has taken the lead. The Dutch potato seed sector is a good example of private sector-led development. Dutch potato seed companies control 70% of the international certified potato seed trade. Two co-operatives, Agrico and HZPC, account for 80% of this market share. There are 250 Dutch potato varieties, 169 of which the country exported in 1994.

The Dutch have achieved their dominant position by specialising in developing new varieties suitable for export and then monopolising their use. This has been achieved by asserting protection via Plant Breeders' Rights (PBR), which lasts up to 30 years. Some 80% of the potato seed exported by the Netherlands in 1996/97 was protected by PBR. In contrast, sales in the national seed market are dominated by certified seed of varieties in the public domain, where competition makes profit margins much lower. PBR has led to concentration of the international potato seed market, which in turn gives the companies a strong bargaining position in countries such as Spain, where imported seed potato accounts for around 70% of total consumption. This translates into high prices and restricted access to varieties.

In contrast, large potato seed companies are absent in North America, where public breeding programmes continue to dominate production. Only one company, PepsiCo's Frito-Lay, is involved in breeding. Publicly developed varieties are released free of charge. One consequence of this is that farmers there are not used to paying royalties for new varieties, and show little interest in buying Europe's PBR-protected varieties.

This means that Europe and the US have quite different potato portfolios. Another is that until recently, there has been little accumulation of capital in the US potato seed industry, so that most seed has been produced by independent growers who are able to sell directly or through a broker. But the entry of the biotech giants into the potato market, particularly Monsanto, is rapidly changing this scenario and weakening the position of the grower (see below). Public sector breeding has been fairly prolific: between 1932 and 1994, the United States and Canada released in average about five varieties every year: some 259 altogether.

In both Europe and North America, breeding programmes have released varieties that foster intensive farming practices and have greatly exacerbated genetic uniformity (see *Seedling,* September 2000, Vol. 17, No 3). Market leaders Russet Burbank (US) and Bintje (Europe) are highly susceptible to virus, blight, nematode and fungus attack and their cultivation relies on heavy pesticide use. But they have very good qualities for the processing industry, which to a point has developed around them The costs associated with adapting processing machinery to new varieties has also contributed to growers' reluctance to adopt greater potato diversity in the crop that they plant.

It is possible that public concern about pesticide use may change the parameters determining variety choice. In Europe, pressures from the large supermarkets are already leading to farmers being required to maintain logbooks on pesticide applications. In the near future, Integrated Pest Management criteria may also be required, which will necessitate the introduction of disease-resistance potato varieties. These are likely to be PBR-protected varieties from the potato seed industry. The substitution of old, public domain varieties with protected varieties would shift the balance of power between potato seed producers and processors back towards the seed industry. But if genetically modified potatoes start to make a big hit on the market, a whole new set of players will appear on the scene.

A big hit with the engineers

Potatoes and genetic engineering have a special relationship. Because of the relatively ease of introducing foreign genes in the potato genome through infection with *Agrobacterium tumefaciens*, the potato has long been a favourite amongst genetic engineers. An analysis of patent applications indicates that it is not the potato seed companies, but the agrochemical

and seed giants, which are leading the way in genetic engineering (see table). Top patent applicants also include large public research institutions (the Max Planck Society and the Cornell Research Foundation), a large chemical group (ICI), an specialised biotech company (Advanced Technologies) and a food processor (Danisco). Most of the 112 patent applicants left hold just one patent application. Somewhat surprisingly, none of the large Dutch potato seed companies have patents on transgenic potatoes, and only two big processors – the Dutch Avebe and the US Simplot – hold patents of their own. The predominance of the agrochemical and seed giants in transgenic potato production has arisen for several reasons. Many patents cover technologies that are to be used in a number of commercial crops, not specifically the potato. Some of the potato-focused patents have arrived via corporate acquisitions. Aventis inherited Plant Genetic Systems' patents and Advanta group acquired those submitted by Mogen, a Dutch biotechnology company. In addition, some agrochemical companies had undertaken

Main patent applicants on genetically modified potatoes

PATENT APPLICANT	PATENTS	%	MAIN ACTIVITY AREAS
Monsanto	33	12	Disease resistance, starch content and genetic engineering techniques
Aventis	17	6	Starch content, flowering regulation
Syngenta	12	4	Disease and insect resistance
Advanta (Mogen)	10	4	Nematode and stress resistance
DuPont	12	4	Starch content, herbicide tolerance
Max Planck Society	10	4	Disease and stress resistance
Cornell Research Found'n	8	3	Late blight and other disease resistance
Danisco	7	3	Starch content
ICI	7	3	Starch content
Cambridge Advanced Tech.	6	2	Starch content, sugar reduction
Japan Tobacco	6	2	Virus resistance, genetic engineering tech.
Top 11 patent holders	128	46	
Remaining 112 patent holders	149	54	
Total patent applications	**277**	**100**	

Source: Compiled by GRAIN from Derwent Technology Abstracts, September 2000

their own R&D. Monsanto has focused on virus and insect resistance, while Aventis' parent company AgrEvo has filed patent applications on potatoes with altered starch content. The priority for research has been to counter the crop's susceptibility to infection, pests and stress, rather than quality traits.

Narrowing objectives: field testing

Field tests of transgenic potatoes have been reported in the United States, Canada, European Union member countries, Argentina, Brazil, Egypt, India, Mexico, Peru, Russia, South Africa and Ukraine. In the US, field test leaders are Monsanto (68%), the Agricultural Research Service of the US Department of Agriculture (9%), and Frito Lay (8%). Potatoes engineered with *Bacillus thuringiensis (Bt)* toxin against the Colorado Beetle have accounted for 48% of all potato field tests, with virus resistance the next most favoured trait (see table opposite). Monsanto has conducted 158 field tests on *Bt*, virus-resistant potatoes. All field tests involving potatoes with altered product characteristics have been undertaken by Monsanto. Up to December 2000, three transgenic potatoes had been authorised for commercial release in the United States, all belonging to Monsanto. They are Bt *NewLeaf TM*, Bt and potato leaf roll virus-resistant *NewLeaf Plus TM*), and Bt and potato virus Y-resistant *NewLeaf Y TM*.

In the European Union (EU), the field test scenario is different. From October 21, 1991 to January 10, 2000, there were 164 field tests involving transgenic potatoes. In contrast with the US, half of these involved an alteration in potato starch content, while insect, virus and fungal resistance accounted for the other half. The potato seed industry has also conducted field tests, mainly on the amylose-free potato developed by Avebe. Other players have included public high-tech centres (the Max-Planck Institute and the Scottish Crop Research Institute), small biotech companies and agrochemical giants Aventis and Advanta. The private sector has also dominated field testing in the European Union. As of December 2000, no transgenic potato had been authorised for commercial release in Europe. Avebe's amylose-free potato, designed for industrial application, was not allowed in the market because it contains a gene coding for resistance to amikacin, an antibiotic.

A global future

The promotion of Northern culinary tastes is pushing potatoes onto the international market. The most evident expression is the rapid expansion of the fast food sector. McDonalds, the sector leader, has increased its outlets outside the US from 2,344 in 1987 to 11,320 in 1998. In 1996, its main competitor, Tricon Global Restaurants (owner of Kentucky Fried Chicken, Taco Bell and Pizza Hut) had 8,620 outlets in some 95 countries.

As international markets for processed potatoes are increasing, so is the pressure for countries to import potato tuber seed. In 1997-1998, Africa accounted for nearly 20% of the Dutch seed industry's potato seed exports. Much of this market is based in off-season production for export to the EU. In 1998, Egypt exported 228,467 metric tons valued at US$ 43.2 million mainly to Europe and the Arab countries. New targets for potato seed exports include Eastern Europe, Asia, Oceania, West Africa and South America. Dutch efforts to increase potato seed exports have not gone unrewarded. In June 2000, Dutch seed companies were the first foreign companies to be allowed into China. *"Today we are opening up a continent,"* announced the Dutch Seed Association in its press release. The potatoes that are to be introduced will be grown by US Simplot and Dutch Farm Frites, and will be processed into chips near Beijing.

Transgenic potato traits field-tested in the US up to August 2000

TRAIT	FIELD TESTS	SHARE (%)	MAIN ACTOR	FIELD TESTS
Insect resistance (*Bt* in all but 1)	308	48	Monsanto	279
Virus resistance (PLRV/PVY)	214	34	Monsanto	179
Fungal resistance	77	12	Monsanto	40
Bacterial resistance	20	3	ARS	17
Nematode resistance	1	0	Monsanto	1
Herbicide tolerance	48	8	Monsanto	58
Modified starch content	58	9	Monsanto	58
Modified solid content	33	5	Monsanto	33
Blackspot bruising	32	5	Monsanto	3

Source: APHIS Biotechnology Permits Database, http://www.aphis.usda.gov/bbep/bp/database.html

The European seed sector is turning potato seed into a global traveller. The US has not traditionally focused on export markets, but this is likely to change in the near future. The traditional isolation of the European and the North American potato sectors will be broken as they compete for international markets. What the outcome of the competition between these publicly-funded and private breeding strategies will be remains to be seen.

In Europe, the strengthening of environmental standards in potato cropping could result in a massive increase in PBR-protected varieties. This would put the seed companies in a position to exert greater influence on European processors at home and abroad. Another key factor determining the future control of potato production will be the degree of adoption of transgenic potatoes, which are currently owned by actors other than European private and US public breeders.

Because potato is such a vulnerable crop, insect, disease and stress-resistant transgenic potato varieties are potentially huge money-spinners. This is the reason why Monsanto has been pushing its insect-resistant and virus-resistant transgenic potatoes very aggressively in the US and beyond. Monsanto has introduced its *NewLeaf* potatoes in Ukraine, without either prior environmental assessments of the potential adverse impacts of these potatoes, nor the consent of either the Environment or Health ministries. Different *NewLeaf* varieties have been field tested in Russia, and they have also been introduced in Georgia.

Up to now, the European potato seed industry has relied on agreements with specialist biotechnology companies to conduct patent-protected genetic engineering research. But if genetic engineering evolves into the main tool for developing new varieties, European seed

breeders may need to develop their own transformation technologies in order to maintain their advantage. The European potato seed industry is most likely to bear these concerns in mind when dealing with the 'hot potato' of genetic engineering. All eyes are on Monsanto's fate. Public opposition to genetic engineering led McCain Foods, Lamb Weston and Simplot, the largest french fry manufacturers in North America, to refuse to buy genetically modified potatoes. *NewLeaf* potatoes labelled as genetically engineered failed to impress the Canadian public. Concern about public rejection is leading the Dutch potato seed industry to *"wait and see"* before they push transgenic potatoes onto the market. They even seem prepared to drop them altogether, which is probably not an option for Monsanto.

Many factors – including the extension of plant breeder protection, the power allocation between the seed and the processing sectors, and the adoption or shunning of genetic engineering – will influence on the future development of the potato. But one thing is for sure: the potato is increasingly becoming bought and controlled by industry. The potato is shifting from being an important family staple to an industrial material. Not only will the potato look and taste different, but this shift will imply dramatic changes in the way in which the potato is produced and in the livelihoods of potato growers around the world.

Main Sources:

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CICDA Dossier

Sprouting Up: REVVING UP THE TRIPS REVIEW

Negotiations on the review of Article27.3(b) of the TRIPS (Trade-Related Intellectual Property Rights) agreement have been at a stalemate since the review began in December 1998. The US, EU and some other developed countries are still resisting a substantive review, which the majority of developing countries in the World Trade Organisation (WTO) have called for. The most comprehensive proposal from the developing countries is articulated in the paper by the African Group, dated 6 August 1999 (WT/GC/W/302). The African Group's proposals have received much support from other developing countries in the WTO, as well as, civil society groups, farmers' movements and NGOs.

However, within the WTO, no real discussion has taken place on these proposals, which seem to be deliberately sidelined at every TRIPS Council meeting. It is therefore crucial that civil society groups around the world mobilise to pressure WTO member countries to break the stalemate and press for a revision of Article 27.3(b) as soon as possible. This pressure is needed now, because:

(1) The mandated review of Article 27.3(b) represents perhaps the only real opportunity to change this provision that allows for patents to be granted on life forms. A mandated review means that proposed changes can be negotiated without the risk of being traded-off against other proposals on other agreements.

(2) The transition period for the implementation of Article 27.3(b) expired on January 1, 2000. This means that the majority of the developing countries are now legally obliged to implement Article 27.3(b) within their national laws. Otherwise, they face the imminent threat of being taken to the dispute settlement body of the WTO.

(3) Even now, patents on life are being granted almost indiscriminately by patent offices, mostly in the North. The patent system is being used to facilitate the theft of biological resources and traditional knowledge from the South. The monopoly control over such essential resources will also have tremendous impact on food security and the livelihoods of farmers and communities in the developing countries.

Third World Network encourages the following actions:

1. Sign on to the Joint NGO Statement on the review of Article 27.3(b)
2. Help disseminate this Statement, and ask others to sign on to it.
3. Join in the global campaign against No Patents on Life.
4. Tell us about your campaigns and actions.

To see the Joint NGO statement, contact Martin Khor/Cecilia Oh at the Third World Network, Penang, Malaysia, Email: twnet@po.jaring.my Web: http://www.twnside.org.sg

INITIATIVES & ACTIONS

People's Caravan marches across Asia

From November 13 -30, the People's Caravan *"Citizen's on the Move for Land and Food Without Poisons!"* marched across India, Bangladesh and the Philippines. The Caravan, comprised of thousands of farmers, landless peasants, farm workers, anti-pesticide and anti-genetic engineering advocates, was protesting globalisation and its potentially devastating effects upon the Asia Pacific region. The Caravan targeted the immoral practices of transnational corporations (TNCs) in their push for corporate dominance and control of local and regional food and agricultural production systems. It advocated genuine agrarian reform to achieve food security, social justice, and land and food without poisons. The last day of the Caravan culminated in a rally in front of the US embassy in the Philippines to commemorate *"One Year since Seattle"* and to condemn US domination on Asian agriculture.

> **For more information, contact: People's Caravan 2000, PO Box 1170, 10850, Penang, Malaysia. Tel: (604) 657 0271/656 0381, Fax: (604) 657 7445, E-mail: pcaravan@tm.net.m/ panap@panap.po.my Web:http://www.poptel.org.uk/panap/caravan.htm**

Via Campesina's Bangalore Declaration

In October, Via Campesina, the global movement of rural women, peasant and small-scale farmers, agriculture workers and indigenous peoples organisations, from Asia, Europe, the Americas and Africa held its 3rd International Assembly. More than 100 delegates from 40 countries representing hundreds of peasant organisations and millions of peasant issued a strong statement outlining Via Campesina's renewed determination to defend its peoples' cultures and rights. According to its Bangalore Declaration, Via Campesina states that, *"We are united in our commitment to confront and defeat the global agenda of neoliberalism. The negative impacts of globalisation are acute and tragic in the countryside. The imposition of the World Trade Organisation (WTO) and regional trade agreements is destroying our livelihoods, our cultures and the natural environment. We cannot, and we will not, tolerate the injustice and destruction these policies are causing."*

> **To see the full declaration, contact Via Campesina, Apdo Postal 3628 Tegucigalpa, MDC Honduras, Central America. Tel & fax: (504) 220 1218, E-mail: viacam@gbm.hn or (for English speakers) cpe@cpefamrers.org**

Regulatory chaos in Russia over GM crops

A new report reveals that field trials of genetically modified (GM) crops are taking place throughout Russia and GM foods are being approved for human consumption, in the absence of any procedures. The report entitled "*Genetically Engineered Food and Crops in Russia"* published by the Russian environmental group Socio-Ecological Union (SEU), reveals that at least 18 notifications for deliberate release of GMOs, including field trials and processing/consumption have been granted. Biosafety measures for field trials are inadequate. *"Field trials of GM apple trees and strawberries in Orel were taking place right next to gardens growing apple trees and strawberries,"* explained Dan Swartz, author of the report, published jointly with ANPED, The Northern Alliance for Sustainability, a network

of non-government organisations based in Amsterdam. The report reveals that the Ministry of Health has approved two varieties of Monsanto's GM potatoes and Monsanto's Roundup Ready (herbicide-tolerant) soybeans for human consumption. In addition, the OECD list also includes approval for AgrEvo's (now Aventis) GE sugar beet.

> **For more information, please contact: Victoria Kolesnikova, SEU, Tel: (7-09) 5124 79 34; E-mail: seupress@online.ru, seupress@yahoo.com or Iza Kruszewska, ANPED, PO Box 12201, London SW17 9ZL, UK. Tel: (44-20) 8672 3454; E-mail: iza@cpa-iza.u-net.com**

Anti-GMO demonstration in Uruguay

On November 20, Uruguayan trade unions, students, organic farmers, NGOs and consumers gathered to voice their opposition to transgenic food and crops at the corporate gathering of the XVII Pan American Seed Seminar in Punta del Este, a luxury seaside resort. *"For life, for diversity, for the people. Against GMO, transnational's globalisation and the commercialisation of life"* was the motto of the protestors, who believe that by investing in GM crops Uruguay could lose the opportunity of selling itself as a *"natural country,"* which still supports livestock production with very low levels of agrochemicals. So far, Uruguay has only authorised the use and sale of Monsanto's Round up Ready soybeans. The demonstration was organized by REDES-Friends of the Earth, Uruguay, GRAIN (Genetic Resources Action International), RAP-AL (Pesticides Action Network-Latin American) and UITA (International Food Worker's Trade Union), and supported by national and Argentinean, Bolivian, Brazilian, Colombian, Costa Rican, Equatorial, Spanish, Honduran and Paraguayan organisations.

> **Contact: Karin Nansen, REDES-AT, Defensa 1684, Montevideo 11200, Uruguay. Tel: (59-82) 402 87 99, E-mail: redes@redes.org.uy**

Finnish NGO seeks support

The newly-founded Citizens Biosafety Association (CBA) in Finland is looking for support to publicise the illegal planting of GM crops in the country. The CBA has discovered that the planting of GM rape is widespread but, in this backwater of public debate on GM foods, this illegal planting is being totally ignored by the relevant authorities. In addition, the CBA has revealed that the officer in charge of preparing GM laws and negotiating with the EU holds a patent with her sister in the USA for GM virus-resistant potato. The CBA is also looking for financial support to produce its video/print report *"Finland - The Wild West of The Genetechnology."*

> **Contact: Hannu Hyvonen, coordinator, Citizens Biosafety Assosiation in Finland, Email: kometsa@sci.fi Web (in Finnish only at present): http://www.bioturva.org/**

Join the Good Food Campaign

India's Research Foundation for Science, Technology and Ecology (RFSTE) recently revealed that in the recent super cyclone that hit the Eastern coastal state of Orissa in India, the *"relief"* package from the US comprised a genetically contaminated corn-soya mix. In response to this and other examples of dumping of GM foods, RFSTE has launched a *"Good Food Campaign."* Organisations and individuals concerned about the dumping of culturally inappropriate, economically destructive foods, which could have serious ecological and health impacts are encouraged join the Good Food Campaign and say no to GM foods. The Good Food campaign will fight for people's food rights, culturally appropriate consumption patterns, locally supportive economic models of production and guaranteed safe foods.

> **Contact: Research Foundation for Science, Technology and Ecology, A-60 Hauz Khas, New Delhi 110 016, India, Tel: (91-11) 656 1868, Fax: (91-11) 656 2093, E-mail: rfste@ndf.vsnl.net.in**

Sprouting Up: BATTLE LINES DRAWN OVER AGENT GREEN

Action against the fungus designed to kill narcotic crops, known as *"Agent Green,"* has been stepping up around the world. Intended to kill opium poppy, coca, and cannabis plants, the microbes present risks to human health and biodiversity. There is imminent danger that a highly infectious fungus will be deliberately released in Andean and Amazonian centres of diversity. The US-backed fungi have already been used experimentally on opium poppy and cannabis in the US and in Central Asia. Fungus targets include hundreds of thousands of cultivated hectares in narcotic crop-producing countries in South, Southeast, and Central Asia, along with Mexico, Central, and South American countries.

Agent Green refers to strains of the fungi *Fusarium oxysporum* and *Pleospora papveracae* that have been developed in the US. These microbes might infect and kill plants other than the targets of coca, poppy, and cannabis in ecologically sensitive areas of Asia and the Americas. Agent Green has only been tested on a limited range of commercial crops, which is little indication of how the fungi will behave in the varied and poorly-understood real-world ecologies where they might be used. *"The USA is playing roulette with irreplaceable biological diversity"* says Susana Pimiento Chamorro, a Colombian lawyer with the Sunshine Project. *"In Colombia, four close relatives of coca are already listed as endangered. Agent Green might be the last step to their extinction."* Local ecology could be drastically affected. One of the most highly prized butterflies in the world, the Agrias (*Agrias sp.*) depends on coca's wild relatives in Amazonian rainforest for its survival.

Even more disturbing is the fact that strains of *Fusarium oxysporum* are highly toxic to animals and humans. Birds feeding on plant seeds are endangered, and consumption of the coca leaves - which is legal in Peru and Bolivia - might pose a health threat. *"Fusaria can produce mycotoxins that are deadly enough to be considered weapons of war and are listed as biological agents in the draft Protocol to the Biological and Toxic Weapons Convention (BTWC),"* says Sunshine Project biologist Dr. Jan Van Aken. There is no exemption in the BTWC, a key international arms control treaty, for the use of biological weapons in military, law enforcement, or civilian actions to forcibly eradicate illicit crops. Countries North and South recognize that prohibiting any use of biological weapons is critically important to stop arms proliferation, uphold treaty commitments, and protect human health and the environment.

Once released into the environment, the deadly fungus cannot be recalled. Indeed, the coca fungus appears to have escaped scientists' grasp when it jumped into control plots during field tests in Hawaii. The fungus has been clearly rejected in the US, the world's number one producer of illicit cannabis. Last year, the Florida Environmental Protection Agency emphatically opposed and halted a proposal to use Fusaria. According to the Agency's director: *"It is difficult, if not impossible to control the spread*

of Fusarium species. The mutated fungi can cause disease in large number of crops… Fusarium species are more active in warm soils and can [reside] in the soil for years."

Senior US officials have failed to obtain the financial backing of other governments for the plan. But this has not stopped US drug warriors from pressuring Asian and South American countries. Through the offices of the UN Drug Control Programme (UNDCP), pressure is being put on Colombia especially, which has already drawn up a plan to eradicate illicit crops. Although the plan is opposed by government officials and civil society both domestically and internationally, the Colombian Environment Ministry has prepared a US $7 million project proposal for work on illicit crops including a major component to develop biological weapons to forcibly eradicate coca crops. The only donor country that has expressed interest is the US, making it the logical funder for the proposal. Earlier this year, Colombia refused to sign a controversial US funded contract with the United Nations Drug Control Program (UNDCP) for the testing of a US-developed *Fusarium oxysporum* strain named EN-4. But it only renounced this single strain. Colombia is moving ahead with the development of *"native"* biological weapons developed from a wide variety of local pathogenic organisms, which it considers will be safer than the US' EN-4.

Colombia's proposal mimics US usage of the deliberately confusing misnomer *"biological control"* when referring to coca-killing agents and spray technology. In fact, they are not legitimate biological controls; but weapons designed to provoke massive disease outbreaks and remain in the soil for decades. The term is being abused by when applied to this biological weapons research. In other parts of the world, a program in Uzbekistan supported by the US, UK, and the UNDCP is developing weapons to eradicate opium poppy. These agents are to be used in conflict-torn parts of Asia, including Afghanistan and Burma.

The US says that the fungus varieties it wants to use in developing countries are not genetically-engineered. But its has created genetically-modified strains in the laboratory. US scientists have also cloned virulent genes from related fungi (*Fusarium* strains that attack potatoes) with the possible intent of increasing the kill rate of anti-drug fungi.

An international network of NGOs including the Sunshine Project, the Latin-America Free of Transgenics network, Accion Andina, the Transnational institute, Accion Ecologica, and many more NGOs in Colombia and all over the world are working to stop all use of biological eradication agents. A number of countries in South America are already considering legislation against the use of biological weapons against illicit crops, and some African countries have also spoken out against their use.

Source: Various press releases and reports from the Sunshine project, available at its website: http://www.sunshine-project.org or by email request from <tsp@sunshine-project...de>, Tel: (1-206) 633 3718

RESOURCES & DOCUMENTATION

In *Syngenta: Switching off farmers' rights?* NGOs denounce the agenda of the new mega-giant: increased control on agriculture, at the expense of the rights of farmers to save seed and develop it to suit their particular growing conditions. It does so through exposing Syngenta's eleven patents covering Genetic Use Restriction Technologies (GURTS), or *"Traitor Technologies."* Traitor technologies leave farmers unable to save seed unless they use proprietary chemicals. The report introduces these technologies, reviews the corporate history and the market position of Syngenta, and analyses each of the 11 traitor patents now owned by Novartis and Astra Zeneca. Perhaps the most striking of these is one that allows the development of plants with impaired immune systems unless chemicals are applied.

> **Hugh Warwick, *Syngenta: Switching off farmers' rights?*, Berne Declaration, Swedish Society for Nature Conservation, GeneWatch UK, Action Aid, October 2000, 26 pp. Available from: Action Aid, Hamlyn House, Macdonald Road, Archway, London N19 5PG, UK. Fax: (44-207) 272 08 99. Web: http://www.actionaid.org**

The spirit of David Downes' *Integrating Implementation of the Convention on Biological Diversity and the Rules of the World Trade Organization* is contained in the assumption that the extent to which trade liberalisation either harms or favours the environment depends to a great degree on how well trade and environmental policies are integrated and balanced. The book aims to contribute to this integration by serving as a background document for closing the knowledge gap between the actors involved in two parallel policy processes: the Convention on Biological Diversity and the World Trade Organisation. The booklet provides an overview of the different fora in which the legal frameworks affecting biodiversity are established. An interesting legal insight.

> **David Downes, *Integrating Implementation of the Convention on Biological Diversity and the Rules of the World Trade Organisation*, IUCN – The World Conservation Union, Gland, Switzerland and Cambridge, UK, 89pp. ISBN: 2-8317-0501-0. Available from: IUCN Publications Services Unit, 219c Huntingdon Road, Cambridge CB3 ODL, UK. Fax: (44-1223) 27 71 75. Email: infoooks@iucn.org**
> **Web: http://www.iucn.org**

'Peoples' Movements' is the thematic focus of the most recent issue of the *Race & Class Journal*. The leading essay gives some basic insights into the struggle for land and justice being carried out by Brazil's Landless Workers' Movement (Movimento dos Trabalhadores Rurais sem Terra, MST). Going back into the story of land reform in Brazil, the author argues that things have deteriorated under the current government, since land ownership remains concentrated in the hands of long-established oligarchies. It goes on to explain MST's success and challenges in its move to garnering support from city dwellers and other social actors. The journal also includes articles on antiracist activism by Ecuatorian Blacks, and Caribbean activist-intellectual popular movements.

> ***Race & Class: a Journal for Black and Third World Liberation*, 42(2), October-December 2000. Published by the Institute of Race Relations, London. ISSN 0306-3968. For subscriptions and single issues contact: Sage**

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Cuba's New Agricultural Revolution: The Transformation of Food Crop Production in Contemporary Cuba, is a report by Food First. The first half of the 1990s witnessed the start of a major transformation of Cuban agriculture, from an emphasis on large state farms to locally-based concerns; from export-oriented production to food crop production; from high technology to alternative technologies. This essay takes a look at the transformation that is currently underway in Cuban agriculture and how – and whether – a number of the dilemmas produced by Cuba's classical model of development are being addressed.

Laura J. Enríquez, *Cuba's New Agricultural Revolution: The Transformation of Food Crop Production in Contemporary Cuba*, Food First, California, USA. Available from: Institute for Food and Development Policy, 398 60th Street, Oakland, CA 94608, USA. Fax: (1-510) 654 4551. Email: foodfirst@foodfirst.org Available on the Web at: http://www.foodfirst.org/pubs/devreps/dr14.html

Two interesting publications received from UPWARD (Users' Perspectives With Agricultural Research and Development), *Sustainable Livelihood for Rural Households: Contributions for Rootcrop Agriculture* is a compilation of contributions from farmers and scientist who participated in the Sixth Annual Conference of UPWARD held in Hanoi, Vietnam in 1997. *Conservation and Change: Farmer Management of Agricultural Biodiversity in the Context of Development,* includes an overview of local maintenance of crop biodiversity in Philippines, among other interesting approaches related to agricultural management of biodiversity in different regions of this country.

***Sustainable Livelihood for Rural Households: Contributions for Rootcrop Agriculture,* UPWARD, Los Baños, Laguna, Philippines, 1998, 211 pp,, ISBN 971-91361-9-7. *Conservation and Change: Farmer Management of Agricultural Biodiversity in the Context of Development*, UPWARD, Los Baños, Laguna, Philippines, 1998, 267 pp, ISBN 971-614-015-0. Both publications are available from: UPWARD, Los Baños, Laguna, PO Box 3127, Makati Central Post Office 1271, Makati City, Philippines. Fax: (63-49) 536 16 62, Email: CIP-Manila@cgiar.org**

SEEDLING

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

SEEDLING

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