Feeding or fooling the world?

Can GM really feed the hungry?

Five year FREEZE
on genetic engineering and patenting in food and farming

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Five Year Freeze

The Five Year Freeze is a campaign run by the Genetic Engineering Alliance, a coalition of 120 UK based organisations, calling for a minimum five year moratorium on:

- Growing genetically modified plants and the production of genetically modified farm animals for any commercial purpose
- Imports of genetically modified foods, plants, farm crops and farm animals and produce from genetically modified plants and animals
- the patenting of genetic resources for food and farm crops.

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Overview

The biotechnology industry is spending millions on persuading policy-makers and consumers from rich, industrialised countries in the Northern hemisphere of the benefits of GM technology. The UK public is regularly faced with claims that genetically modified (GM) crops have the potential to "feed the world" and that by opposing their acceptance in the UK, they are holding up research which could benefit the hungry in other parts of the world. The message is that failure to accept GM will condemn millions of people in Southern* countries to death by starvation.

New developments in GM technology, such as a rice strain which reportedly boosts yields by up to 35%,[1] and 'golden rice' (GM pro-vitamin A enhanced rice) have been heralded as miracle crops that will help save 800 million hungry people worldwide from disease and death.

This timely briefing opening up the vital discussion on food security will take a critical look at the arguments put forward by the biotechnology industry. The GM debate has presented a long overdue opportunity for policy-makers, campaigners and the food industry in both North and South to consider the most viable and long-term solutions to tackling world hunger.

This briefing looks at the key causes of world hunger, and the reasons why hunger persists. It argues that the promotion of GM technologies to solve world hunger:

- Is driven by the race of the biotechnology industry to be first to market products and claim financial rewards;
- Over-simplifies the issues;
- Detracts from proven strategies and action that could more effectively and sustainably address world hunger if given financial and political backing;
- Overlooks the risks to biodiversity and to human and animal health.

The briefing has been compiled from scientific documents and research; evidence collected from monitoring the media debate on GM issues; articles; reports; letters; literature from the agrochemical, seed and genetic engineering industries; and experience of alternative solutions.

The primary objectives of this briefing are to:

- analyse claims that GM crops can feed the world, and to challenge the assumptions on which these claims are based;
- bring Southern voices and concerns to the forefront of the debate;
- raise questions about the way patenting and corporate control over agriculture negatively affect farmers' livelihoods and food security worldwide.
- explore the reasons why high-profile GM technologies such as golden (GM pro-vitamin A enhanced) rice, if they can address the complex problems of dietary deficiencies at all, will only ever address part of the problem;
- show that effective solutions to hunger must address poverty, exclusion and inequality;
- highlight sustainable, affordable and efficient non-GM approaches to reduce world hunger;

It is hoped that this briefing will be a catalyst for further research, debate and action on the vital endeavour of addressing the reasons why 790 million[2] of our fellow citizens currently go hungry.

* Note

Throughout this document, *the South* is a term used to refer to those countries with low per capita incomes, also known as 'less developed' countries or the Third World. *The North* refers to the industrialised countries in Europe and North America together with Japan, Australia and New Zealand.

"We strongly object that the image of the poor and hungry from our countries is being used by giant multinational corporations to push a technology that is neither safe, environmentally friendly, nor economically beneficial to us. We do not believe that such companies or gene technologies will help our farmers to produce the food that is needed in the 21st Century. On the contrary, we think it will destroy the diversity, the local knowledge and the sustainable agricultural systems that our farmers have developed for millennia, and that it will undermine our capacity to feed ourselves."

'Let Nature's Harvest Continue!' Response to Monsanto from Delegates from 20 African Countries to the Food and Agriculture Organisation of the UN.[3]

"Bangladeshi people do not need GM food. GM food means the destruction of farmers and letting the companies take over....We need to preserve a biodiversity-based food production without the application of poisonous chemicals. Bangladeshi farmers are rejecting the idea that GM food can meet the needs of hungry people. This is nonsense. GM can feed the GREED of the companies, not the NEED of the hungry people. People are hungry not because we are not able to produce, but because the food production base is being systematically destroyed by the interventions of the profit-seeking companies. They want to make business out of our hunger!"

Farida Akhtar, UBINIG. Policy Research for Development Alternatives, Bangladesh.[4]

1 Introduction

Proponents of GM technology say that genetically modified (GM) crops will end world hunger by increasing agricultural yields and improving nutrition. Millions are being spent on advertising and PR campaigns to persuade European, Australian and North American consumers and policy makers to accept GM crops. We are told that failure to do so will condemn millions of people in Southern countries to death by starvation.

> *"We have the means to end hunger on this planet and to feed the world's six billion - or even nine billion - people. For the well fed to spearhead campaigns and suppress research into potential solutions for ideological or pseudo-scientific reasons is downright irresponsible and immoral."*
>
> C.S. Prakash, Ag Bio Forum.[5]

What do people in Southern countries think of the promises made for GM crops? These are the very people who, it is claimed, will benefit most from the new technologies. So far their voices have been mute conspicuously absent from the debate. Yet increasingly organisations and individuals from across Africa, Asia and South America are questioning the assertions made by the biotechnology industry. And, as in Northern countries, calls for outright bans or moratoriums on GM crops are gaining strength.

As in the North, the concerns of Southern countries include the environmental threats and human health risks associated with genetic engineering. In addition there are also vital social and economic aspects "intertwined with the problem of the emergence of global control over the food chain and human health by a few transnational companies".[6]

1.1 What is hunger?

Hunger is defined by the UN Food and Agriculture Organisation's Committee on World Food Security as:

> *"Physical, emotional and psychological distress arising from lack of access to adequate, nutritious food."* [7]

Following this definition, people are hungry if they don't get enough food (low calorie intake) or if that food is not of sufficiently high quality (i.e. containing essential micronutrients). In many parts of the world severe diseases and disabilities are caused by the lack of essential vitamins and minerals necessary to maintain physical and psychological health. The GM industry and others promise solutions to these problems in the form of nutritionally enhanced foods ('nutraceuticals' or 'functional foods'), such as pro-vitamin A rice.

EAST AFRICA: TACKLING STEM BORER AND...

In East Africa, maize fields face a major pest called the stem borer. Most years, its larvae eat their way through a third of the region's maize. But researchers discovered that the borer is even fonder of a local weed, napier grass. By planting the grass in their fields, farmers can lure the stem borers away from the maize where they die, trapped by a sticky substance produced by the grass. A secondary benefit of the grass is that it can be harvested and sold as animal feed - giving the farmer extra income. Trials of the technique are taking place on 2,000 African farms, and are already showing yield increases of up to 70%.

Research of Ziadin Khan, Mbita Point Research Station, Lake Victoria, Kenya.[8]

"...deep underlying political, economic and social problems prevent the just distribution of food, even if enough is produced. The reductionist approach of these quick fixes is ignoring bigger underlying problems which constrain farmers from achieving higher agricultural yields. Access to land and capital, unstable market prices, poor infrastructure like farm-to-market roads and post-production facilities are problems that need to be addressed."

MASIPAG Farmer/Scientist Partnership for Development, Philippines.[9]

"In Bukidon (Philippines), if lands were to be distributed equally among its people, each family would have at least five hectares to till... if the fruits, rice, corn, vegetable and other gifts from the land were to be partaken equally by its people, no one would ever get hungry."

Kaloy Manlupig, of the Balay Mindanaw Foundation in the Philippines.[10]

"If the food that is currently available were to be evenly distributed among the 6.4 billion people on the planet (providing each individual with a minimum intake of 2,500 calories), there would still be a surplus left for 800 million people. The problem, therefore, is not of production, but clearly of access and distribution. It involves more of politics than technology, with biotechnology having virtually no role to play."

Devinder Sharma, President of the Forum for Biotechnology and Food Security, New Delhi, India.[11]

1.2 What causes hunger?

Clearly, hunger is inextricably linked with poverty. People don't have food in sufficient quantity, or of sufficient quality, because they either lack money to buy food that is readily available or that they are deprived of access to, control over or ownership of the productive resources necessary to produce it themselves. Of the world's 6 billion people, 2.8 billion live on less than $2 a day and 1.2 billion on less than $1 a day.[12] Both hunger and poverty are exacerbated by war: conflict-ridden countries such as Liberia, Somalia and Sierra Leone are among the world's hungriest.[13] Significantly, however, hunger and poverty result from trade and economic policy decisions that lead to increasing inequities in distribution of food and income. Policy choices concerning the following issues are particularly important in this regard:

- Infrastructure, such as roads, refrigeration, storage;
- Education and training, especially for women;
- Balance between rural and urban populations, including the speed of change in this balance;[14]
- Terms of trade;
- Control over resources and means of production, especially access to land and water.[15]

1.3 Can GM feed the world? The claims:

The claims made for GM crops are compelling. Using predictions that the population will reach eight billion by 2020,[16] proponents of GM technology say that:

- GM will feed the hungry by increasing agricultural yields;[17]
- GM will overcome micronutrient malnutrition through the development of 'functional foods' or 'nutraceuticals';[18]
- GM will contribute to sustainable food production through the use of marginal lands and decreased use of inputs (such as pesticides).[19]
- GM research and related patents are addressing the needs of the poor and hungry.

The assumptions underlying these claims are examined in this briefing.

...ACTION AGAINST STRIGA

IN EAST AFRICA, A MAJOR PEST CALLED STRIGA, A PARASITIC PLANT, WRECKS $10 BILLION WORTH OF MAIZE CROPS EVERY YEAR, THREATENING THE LIVELIHOODS OF 100 MILLION AFRICANS. RESEARCHERS HAVE FOUND THAT WHERE FARMERS PLANT *DESMODIUM*, A COMMON WEED, BETWEEN THE ROWS OF MAIZE, STRIGA WON'T GROW. THE TECHNIQUE OF PLANTING *DESMODIUM* IS NOW BEING ADOPTED ACROSS THE REGION, WITH ALREADY IMPRESSIVE INCREASES IN MAIZE YIELD.

Research of Ziadin Khan, Mbita Point Research Station, Lake Victoria, Kenya[20]

"Much of the rice diversity has already been lost under the guise of feeding the world during the Green Revolution. Forty years later, the same strategy but under a different name comes to wreak the same havoc. IRRI [International Rice Research Institute] has even served as a means by which industrialised countries have come to access resources for their own benefit - without any returns to the farmers from developing countries. A dark cloud of genetic uniformity is already gripping Asian fields today with production being confined to only a few varieties. This is a very dangerous situation for farmers and food security since it increases dependence on toxic chemicals and genetic engineers to help defend crops against inherent weaknesses of biological uniformity."

MASIPAG, Farmer/Scientist Partnership for Development Inc., Philippines.[21]

2 Can GM crops end hunger by increasing agricultural yields?

"...many of our needs have an ally in biotechnology and the promising advances it offers for our future. Healthier, more abundant food. Less expensive crops... With these advances we prosper; without them we cannot thrive. As we stand on the edge of a new millennium, we dream of a tomorrow without hunger... Worrying about starving future generations won't feed them. Food biotechnology will."

Monsanto European advertising campaign, 1998. [22]

Claims that GM crops can end hunger by increasing agricultural yields seem straightforward enough. But if we are really to address the problem of 800 million hungry people, the assumptions underlying the simplistic equation "more food = less hunger" must be properly examined. The following challenging questions arise:

- Is hunger caused by scarcity of food?
- Is hunger the result of an increasing population?
- Do GM crops really have a higher yield than traditional varieties?
- What does 'yield' mean? The amount of one specific crop produced by an area of land? Or the total amount of useful crops produced by that land?
- Are GM crops stable and consistent enough to depend on in the future?
- Would there be detrimental effects resulting from the widespread use of GM crops?

These questions are examined below.

2.1 Claim: People are hungry because not enough food is produced

"Concerning the future, [...] for the world as a whole there is enough, or more than enough, food production potential to meet the growth of effective demand."

Food and Agriculture Organisation of the UN.[23]

A popular belief is that there will have to be a massive increase in food production because the population is increasing dramatically and will continue to do so. Proponents of GM technology claim that GM will meet this need and that current or traditional agricultural methods cannot. These ideas are flawed in a number of ways, including the following:

DIVERSIFICATION IN NEPAL

IN 31 VILLAGES IN NEPAL, A RURAL DEVELOPMENT PROJECT PROMOTING SUSTAINABLE FOOD PRODUCTION SHOWS HOW A COMMUNITY-BASED PROCESS CAN BUILD UPON THE SKILLS AND KNOWLEDGE OF LOCAL PEOPLE AND PROFESSIONALS TO PRODUCE WIDE-RANGING BENEFITS. 40% OF HOUSEHOLDS ARE NOW ENTIRELY FOOD SELF-SUFFICIENT THROUGH INCREASED USED OF REGENERATIVE AGRICULTURE TECHNOLOGIES, INCLUDING GREEN MANURES, COMPOSTING, INTER-CROPPING, AGROFORESTRY, AND INCREASED DIVERSIFICATION OF FARM SYSTEMS THROUGH INCORPORATING FRUIT TREES, BEES, SHEEP, RABBITS, COTTON, FLOWERS AND THE INTENSIFICATION OF KITCHEN GARDENS. THE PROGRAMME ENCOURAGES THE USE OF SMOKELESS STOVES AND PIT LATRINES WHICH HAVE IMPROVED RESPIRATORY HEALTH AND, SUBSEQUENTLY, LABOUR PRODUCTIVITY. IT INVOLVES COMMUNITY GROUPS MANAGING LOCAL SAVINGS AND CREDIT SYSTEMS TO SUPPORT SMALL BUSINESSES, AND HAS STRENGTHENED ADULT EDUCATION AND IMPROVED ACCESS TO HEALTH FACILITIES.

Work of the Jajarkot Permaculture Programme, Nepal.[24]

"It is argued that the Indian peasants in Chiapas, Mexico are backward, they produce only two tons of maize per hectare as against six on modern Mexican plantations. But this is only part of the picture. The modern plantation produces six tons per hectare and that's it. But the Indian grows a mixed crop. Among his corn stalks, that also serve as support for climbing beans, he grows squash and pumpkins, sweet potatoes, tomatoes and all sorts of vegetables, fruit and medicinal herbs. From the same hectare he also feeds his cattle and chickens. He easily produces more than 15 tons of food per hectare and all without commercial fertilisers or pesticides and no assistance from banks or governments or transnational corporations".

José A. Lutzenberger, agronomist, former Minister of the Environment and long-time campaigner for Ecological Agriculture Against Agrotoxins, Brazil.[25]

- More than enough food is currently produced to feed everyone in the world a basic nutritious diet, but people still go hungry;[26]
- Global food production per person has outstripped population growth by 16% over the past 35 years[27] (due in part to the Green Revolution, see section 2.3), and the UN Food and Agriculture Organisation (FAO) predicts it will continue to do so for at least the next 30 years[28], even without factoring in GM crops;[29]
- The latest UN analyses of population figures show that population growth rates are stabilising[30]
- Hunger persists even in the richest countries in the world where there are food surpluses: 33 million people in the US live in conditions described as food insecure;[31] in the UK, 5 million people live in absolute poverty, unable to meet basic needs including buying adequate food;[32]
- Hunger persists even in countries where food is being exported. For instance, in Sub-Saharan Africa, home to 213 million malnourished people, exports are growing more rapidly than imports;[33]
- Nearly 80% of malnourished children in the South live in countries that have food surpluses;[34]
- Countries with high population densities are not necessarily associated with high levels of hunger. For every densely populated, hungry country, such as Bangladesh, there is a sparsely populated and hungry country such as Brazil or Costa Rica, or densely populated, well-fed countries, such as the Netherlands. The places where hunger occurs are where there is poverty and inequality;[35]

These facts indicate that hunger persists because of a lack of political will to address problems of food access and distribution. As long ago as 1986, a World Bank study concluded that hunger could only be stopped by "redistributing purchasing power and resources" to the people without enough to eat.[36] Without addressing this underlying problem, proponents of GM are avoiding the real causes of hunger and food insecurity.

2.2 Claim: GM crops will increase agricultural yields

Proponents of GM technology say that it can address world hunger with increased and more reliable agricultural yields, but yield is both a narrow measure of agricultural success and a false indicator of whether people are achieving a balanced diet that will protect them from hunger and disease. Furthermore:

- GM crops are designed to be grown as industrial monocrops (a single crop per field). But total productivity of mixed-crop land has been shown repeatedly to far outstrip monocrops in total useful output.[37] This mixed cropping not only helps the

THE BENEFITS OF MIXED CROPPING

SMALL FARMS IN MEXICO SHOW THE BENEFITS OF MIXED CROPPING, WHERE IT TAKES 1.73 HECTARES OF LAND PLANTED WITH MAIZE TO PRODUCE AS MUCH FOOD AS ONE HECTARE PLANTED WITH A MIXTURE OF MAIZE, SQUASH AND BEANS. "THE DIFFERENCE COMES FROM THE REDUCTION OF LOSSES DUE TO WEEDS, INSECTS AND DISEASES AND A MORE EFFICIENT USE OF THE AVAILABLE RESOURCES OF WATER, LIGHT AND NUTRIENTS".

Miguel Altieri, Agricultural Economist, University of California, USA.[38]

"Too often the new technologies have been injected into communities with rapidly growing populations already dominated by excessive inequalities where, in the absence of countervailing policies, the powerful and the better-off have acquired the major share of the benefits. As a consequence a high proportion, over 20% of the developing world's population, is still poor and hungry."

Gordon Conway, agricultural ecologist and President of the Rockefeller Foundation, New York.[39]

farmer, but it benefits dietary diversity and human health, soil maintenance, the environment, crop and biological diversity, and local economies.[40]

- A 1998 study by the USDA Economic Research Service showed that yields were not significantly different in GM versus non-GM crops, in 12 of 18 crop/region combinations.[41]
- A study examining over 8,000 field trials found that GM Roundup Ready soybean seeds produced fewer bushels of soybeans than conventionally bred varieties.[42]
- Crop failures (and therefore drastically reduced yields) have already occurred in GM soya and cotton plants[43] - due to unexpected effects/behaviour, such as brittleness that made soya plants incapable of withstanding heat waves.[44]
- Seed patenting and industrial control of agriculture are ensuring that just a few standardised commercial crops are grown, making the world's food sources more vulnerable to disease. UN figures show that only 30 types of crop now feed the world, providing 95% of calorific and protein requirements.[45]

2.3 Claim: The Green Revolution demonstrated the success of technical solutions

The Green Revolution of the 1960s and 1970s was based on the belief that replacing traditional crops with high-yielding varieties reliant on chemical inputs could end world hunger forever. Although this approach was successful at boosting crop yields in many cases, the long-term objective of eliminating hunger and rural poverty has not been met. There is evidence that farmers, the hungry poor and the environment are still paying the price of green revolution agriculture that has:

- Degraded soils, eroded biodiversity and contaminated groundwater systems;[46]
- Increased poverty,[47] and instigated new problems of nutrient deficiency[48] and toxic pollution,[49] with sometimes catastrophic consequences for families and communities.

The Green Revolution was unsuccessful in considering the needs of the small farmers - the millions of families world-wide who rely on subsistence farming, without expensive inputs of agrochemicals. Rather than support local expertise suited to local conditions, the Green Revolution concentrated wealth, land and power in the hands of the few farmers who

RICE PRODUCTION IN MADAGASCAR

RICE PRODUCTION IN MADAGASCAR ON SMALL FARMS HAS BEEN BOOSTED FROM 3 TO 12 TONNES PER HECTARE USING SIMPLE, NON-CHEMICAL TECHNIQUES AND EXISTING RICE STRAINS. THE TECHNIQUE RESTS ON THE FOLLOWING PRINCIPLES: SEEDLINGS ARE TRANSPLANTED EARLIER THAN USUAL IN SMALL NUMBERS SO THAT MORE SURVIVE; RICE PADDIES ARE KEPT UNFLOODED FOR MUCH OF THE GROWING PERIOD; COMPOST IS USED RATHER THAN CHEMICAL FERTILISERS. THE IDEA IS SO SIMPLE AND HAS BEEN SO SUCCESSFUL, IT HAS SPREAD LIKE WILDFIRE. ALREADY 20,000 FARMERS HAVE ADOPTED IT IN MADAGASCAR. THE TECHNIQUE IS ALSO BEING TESTED IN CHINA, INDONESIA AND CAMBODIA IN A RESEARCH PROJECT COORDINATED BY CORNELL UNIVERSITY IN NEW YORK.

Research of Henri de Laulaine, Tefy Saina Research Association, Madagascar.[50]

"Punjab and Haryana were at the forefront of the Green Revolution in the late 1960s and early 1970s, in which farm machinery, pesticides and fertilisers, irrigation and the replacement of traditional crops with high-yielding varieties dramatically increased productivity. The two states together now provide 80% of the country's food surplus. But the land is increasingly unable to support this burden of intensive agriculture. Crop yields - and water resources - are declining alarmingly, and some parts are close to becoming barren. Many farmers are heavily in debt from their investments in new equipment and reliance on chemicals, and rural unemployment is increasing. These are ominous signs of a deteriorating farm economy."

Devinder Sharma, Forum for
Biotechnology and Food Security, New Delhi, India.[51]

were able to afford the seeds and inputs. This contributed to the migration of millions of farmers to the cities in search of work - the new urban poor.

The arrival of GM technology has been termed the 'Gene Revolution', partly because the claims made for GM crops are so similar to those made for the crops of the Green Revolution. We are told once again that new technology is the means to end hunger. But many fear that GM technologies will only intensify the process of agricultural industrialisation, with renewed threats to the remaining small farmers, rural and urban economies, soils, biodiversity, water supplies, crop stability and human health.

2.4 Claim: GM crops offer significant environmental and agricultural benefits

It is becoming clear that the increased yields of the Green Revolution did not come without considerable social and environmental costs, and that rates of growth in agricultural production are now falling. Lessons to be learned from the Green Revolution include:

- High-yield crop varieties require carefully controlled conditions, often requiring more water and resources than farms and farmland can adequately supply or sustain;[52]
- Soils around the world have been seriously degraded and eroded by Green Revolution techniques;[53]
- Increased use of agro-chemicals (including a six-fold increase in fertiliser use in India) applied to stave off crop failures have not been matched by corresponding increases in yields, and have disrupted healthy farmland ecosystems;[54]
- Strict monoculture regimes are more susceptible to pest attacks and disease outbreaks, leading to localised loss of production or necessitating the regular application of chemical pesticides.[55]
- Monoculture regimes reduce local dietary diversity and, therefore, micronutrient intake.
- The use of crop residues as animal feed is reduced or even eliminated because there is less of it and because the stems are tough and indigestible for the animals.

The development of GM technology to-date has not been part of a holistic approach to address these systemic problems, nor has it been oriented towards rebuilding healthy farm ecosystems that could support a rich and sustainable variety of crops. It therefore threatens to further increase reliance on low diversity and chemically-dependent industrial farming, and perpetuate the problems outlined above.

IMPROVED NUTRITION IN ETHIOPIA

A PROJECT IN ETHIOPIA HAS INTRODUCED NEW VARIETIES OF VEGETABLES AND FRUIT AND FOREST TREES, PROMOTED MANURE FOR SOIL FERTILITY, AND INTRODUCED VETERINARY SERVICES. 12,500 FARM HOUSEHOLDS HAVE ADOPTED SUSTAINABLE AGRICULTURE ON ABOUT 5,000 HECTARES, RESULTING IN A 70% IMPROVEMENT IN OVERALL NUTRITION LEVELS WITHIN THE PROJECT AREA AND A 60% INCREASE IN CROP YIELDS. SOME FARMERS HAVE BEGUN TO PRODUCE A SURPLUS THAT THEY SELL IN LOCAL MARKETS, EARNING MUCH NEEDED INCOME FOR THEIR FAMILIES. AN AREA THAT ONCE RELIED ENTIRELY ON EMERGENCY FOOD AID IS NOW CAPABLE OF FEEDING ITSELF.

Work of the Cheha Integrated Rural Development Project, Ethiopia.[56]

"Herbicide resistance... excludes the possibility of rotational and mixed cropping that is the basis of sustainable and ecologically balanced forms of agriculture and food security."

Vanaja Ramprasad of the GREEN Foundation, Bangalore, India.[57]

"...private proprietary science will focus on crops and innovations that will find rich markets and ignore those of interest to poor, small farmers."

Ismail Serageldin, chair of International Agricultural Research Organisation (CGIAR). [58]

A growing body of evidence shows that GM crops are already developing problems. These are often the very GM varieties that were promoted as offering significant agricultural, environmental or economic benefits. For instance:

- Crops engineered to produce their own pesticide (e.g. Bt Cotton) increase the exposure of pests to the pesticide, thereby accelerating the emergence of resistant strains;[59] undermine relatively inexpensive pest management systems,[60] and harm beneficial pest-control and pollinating insects, thereby creating a niche for insects that previously were not behaving as pests;[61]
- Crops engineered to be tolerant to herbicides (e.g. RoundUp Ready Soya, or Liberty Link corn) may harm soil fertility,[62] exacerbate soil erosion, lead to increased used of chemicals and kill beneficial insects, birds and animals;[63]
- Crops engineered to be resistant to viruses (e.g. sweet potato and papaya) could result only in short-lived resistance that increases vulnerability over the long-term;[64]
- GM plants tolerant to more than one herbicide are already beginning to appear, requiring the application of mixtures of herbicides to eliminate them.[65]

2.5 Claim: GM crops will help farmers use 'marginal' land so protecting forests and precious ecosystems

"Future advances could produce hardier crops in such abundance that farmers would be less vulnerable to the vagaries of weather and less inclined to carve out new land from rain forests because their old fields were exhausted."

Laurent Belsie, staff writer of The Christian Science Monitor. [66]

Proponents of GM technology say that GM crops can be developed to grow in harsh conditions, including land affected by drought or salt. However, currently most GM crops are designed to meet the needs and tastes of Northern markets (see section 4.2). In 2001, herbicide tolerance and insect resistance characteristics accounted for virtually 100% of all GM crops grown.[67]

Some agencies have been set up for research in developing countries (funded by the public sector, the World Bank and the Rockefeller Foundation), but the relative scale is small.[68] Overall, as the FAO states, "biotechnology research does not focus on the needs or interests of developing countries".[69] Less than 1% of all GM crops are engineered to be suited to cultivation on marginal land.[70] Although there have recently been breakthroughs claimed in

IRRIGATION MANAGEMENT IN THE PHILIPPINES

CHANGES IN THE WAY IRRIGATION INFRASTRUCTURE IS PLANNED AND BUILT HAVE CONTRIBUTED TO A RISE IN RICE YIELD IN THE PHILIPPINES. LOCAL FARMERS ARE NOW INVOLVED FROM THE START IN DETERMINING THE LAYOUT OF PROPOSED SYSTEMS AND IN CONSTRUCTING DAMS AND CANALS. ONCE COMPLETE, CONTROL OVER THE WATER SYSTEMS IS HANDED OVER BY THE NATIONAL AUTHORITIES TO FARMER-LED IRRIGATION ASSOCIATIONS. BY THIS SIMPLE CHANGE, RICE YIELDS IN SOME PARTS OF THE PHILIPPINES HAVE INCREASED BY 20%.

Work of the National Irrigation Administration, the Philippines. [71]

"I don't believe that there can be crops that would withstand continuing land degradation. Such crops will need some water. But there is no water. You can't manage a crop that grows on bare rock."

Tewolde Egziabher, Africa's spokesperson on biotechnology at the UN.[72]

the development of, e.g.: salt tolerant tomatoes,[73] no research has yet been done into their safety for human consumption or the environment. Drought tolerance involves a number of genes and will be far more difficult to engineer. Moreover, non-GM solutions exist or are being developed to grow food on marginal land.

In addition, it is important to remember that the need to cultivate marginal lands often arises from the displacement of farmers from the most productive agricultural land by urbanisation, and large-scale commercial concerns, including production for export. In Brazil, for instance, more land is owned by multinational corporations than all the subsistence farmers put together.[74] In the Philippines since 1991 agricultural lands are being sacrificed for other uses at a rate of 27,000 hectares a year.[75]

SOIL AND WATER CONSERVATION IN BURKINA FASO AND NIGER

SOIL AND WATER CONSERVATION IN THE DRYLANDS OF BURKINA FASO AND NIGER HAS BROUGHT REMARKABLE TRANSFORMATIONS OF FORMERLY DEGRADED AND ABANDONED LANDS. 100,000 HECTARES HAVE BEEN RESTORED DURING THE 1990S, EACH NOW PRODUCING 700-1,000KG OF CEREAL PER YEAR. THE AVERAGE FAMILY HAS SHIFTED FROM A CEREAL DEFICIT OF 644KG PER YEAR - EQUIVALENT TO SIX AND A HALF MONTHS OF FOOD SHORTAGE - TO PRODUCING AN ANNUAL SURPLUS OF 153KG. FARMERS DIG HOLES WHICH HARVEST WATER WHEN IT RAINS. THE TECHNIQUE HAS SPAWNED A NETWORK OF YOUNG DAY LABOURERS WHO DIG AND MAINTAIN THE HOLES AND WHO, RATHER THAN MIGRATING TO THE CITIES, NOW GO FROM VILLAGE TO VILLAGE TO SATISFY FARMERS' GROWING DEMANDS FOR SUSTAINABLE AGRICULTURE.[76]

"Bangladeshi people do not need pro-vitamin A Rice to combat vitamin A deficiency. Bangladeshi food diversity contains enough sources of vitamin A and other nutrients that are necessary for human nutrition These should be promoted. ...We will do anything to stop exploitation of the people's hunger and malnutrition."

Farida Akhtar, UBINIG. Policy Research for Development Alternatives, Bangladesh.[77]

"The Green Revolution encouraged us to think about food security in terms of quantity of food. But there is a growing interest in analysing the quality of food. Some Green Revolution crops are poor in vital nutrients such as calcium, iron, and vitamins C and A. But often, under-utilised crops are rich in these nutrients. One study found four African home-garden crops, leafy vegetables with twice the micronutrients of spinach."

Stefano Padulosi, Head of Under-Utilised Food Crops,
International Plant Genetic Resources Institute, Rome.[78]

3 Can GM technology help overcome 'micronutrient malnutrition'?

In many parts of the world micronutrient malnutrition - the lack of vitamins and minerals essential to physical and psychological health - causes more health problems than lack of protein or calories. This 'hidden hunger' is not just a problem confined to developing countries but is found in areas of the industrialised north as well. In the US, one in five children live in families which are food insecure.[79] The biotechnology industry promises technical solutions to these problems[80] with crops engineered to contain enhanced levels of vitamins and minerals.

The most highly publicised of these GM crops is pro-vitamin A enhanced ('golden') rice. As the 'acceptable face' of genetic engineering, golden rice has been used to persuade consumers of the potential benefits of GM technology. But can such crops really address malnutrition?

Vitamin A deficiency (VAD): the problem

- Over one million VAD-associated childhood deaths occur annually.
- 14 million pre-school children already have some eye damage due to VAD.
- At least 350,000 pre-school children become partially or totally blind every year from VAD; about 60% die within a few months of going blind.
- VAD is associated with an increase in the severity of infections, particularly measles and diarrhoea disease.

Source: World Health Organisation.[81]

3.1 Claim: Pro-vitamin A enhanced (golden) rice is the solution to vitamin A deficiency

"The levels of expression of pro-vitamin A that the inventors have achieved, are sufficient to provide the minimum level of pro-vitamin A to prevent the development of irreversible blindness affecting 500,000 children annually, and to significantly alleviate Vitamin A deficiency affecting 124,000,000 children in 26 countries."

Dr. Adrian Dubock, executive from Zeneca (now Syngenta), the company that would market the pro-vitamin A enhanced (golden) rice.[82]

Vitamin A deficiency (VAD) is a public health problem in over 75 countries. Children in Southern countries suffer most from this condition, which is largely preventable. GM pro-vitamin A enhanced rice is being advocated as a solution to VAD in Southern countries[83] - particularly in Asia, where rice is a staple food. Genetic material has been engineered into a strain of rice to make it rich in beta-carotene, a micronutrient that is converted to vitamin A in the human body and which gives it its golden colour.

GM pro-vitamin A enhanced rice is unlikely to address the problems of vitamin A deficiency because it can not address the fact that micronutrient deficiencies such as VAD are symptoms of more general deprivation experienced in the context of poverty, poor hygiene, environmental degra-dation and social inequality.

"As compared with the challenge of controlling protein-energy malnutrition, elimination of vitamin A deficiency can be achieved rapidly. The cost-effectiveness ratio is also highly favourable. It is therefore a test case of political will, and managerial capacity to implement known technologies and known solutions."

World Health Organisation, 2000.[84]

"The public relations uses of Golden Rice have gone too far. The industry's advertisements and the media in general seem to forget that it is a research product that needs considerable further development before it will be available to farmers and consumers."

Gordon Conway, President of the Rockefeller Foundation.[85]

For example:

- Consuming an average diet of 300g of Golden Rice a day, an adult would receive only 8% of their required daily intake of vitamin A. In effect, someone would have to eat 9kg of cooked rice (equivalent to 3.75kg uncooked) a day to satisfy the required intake. A pregnant woman would need twice that amount.[86]
- Polluted drinking water can give rise to intestinal parasites that impair absorption of micronutrients;
- Low income usually limits dietary intake to a narrow, nutritionally deficient range of foods.
- Many essential micronutrients need to be eaten in the presence of other foods to allow them to be absorbed by the human body (e.g. vitamin A in the presence of fat; vitamin C in the presence of zinc).[87]
- Many children exhibiting symptoms of vitamin A deficiency, suffer from generalised protein-energy malnutrition which interferes with the absorption of β-carotene and its conversion to vitamin A.[88]

Pro-vitamin A enhanced rice is still several years away from reaching the bowls of those who need help. At least four years of trials are still necessary[89] and experiments have so far failed to produce a rice plant of the type grown in Asia. Even if a viable plant is developed, it will have to be thoroughly tested to determine if it is safe and effective to grow and eat. Even then it will only work if it is made accessible to and affordable for the people who need it. Meanwhile claims that pro-vitamin A enhanced rice offers a "quick-fix cure" for VAD risk diverting attention from relatively low-cost, but effective, initiatives, which can help people to achieve a better diet almost immediately.

In their Plan of Action, the UN's World Health Organisation (WHO) and International Children's Fund (UNICEF) advocate a holistic range of solutions to the problem of Vitamin A deficiency (and other dietary deficiencies). These include:

- Promoting breastfeeding;
- Dietary diversification;
- Promoting crops naturally rich in Vitamin A (such as leafy green vegetables);
- Food fortification;
- Food supplements.

The UN's Food and Agriculture Organisation (FAO) has shown that the greater the variety of fruits and vegetables eaten, the better the uptake of vitamin A. The FAO advocates education and the promotion of local and home-based vegetable and fruit production. This approach not only addresses vitamin A deficiency in an affordable and sustainable way, it has also resulted in an overall improvement of family health, addressing other health problems associated with diet.

SOYA AND MAIZE YIELDS RISE IN SOUTHERN BRAZIL

THREE SOUTHERN STATES IN BRAZIL - SANTA CATERINA, PARANÁ AND RIO GRANDE - HAVE ADOPTED TECHNIQUES ON 9 MILLION HECTARES OF LAND TO CONSERVE WATER AND SOIL. THE MAIN TECHNIQUES ARE CONTOUR GRASS BARRIERS, GREEN MANURES AND CONTOUR PLOUGHING (ALTHOUGH MOST FARMERS NOW NO LONGER PLOUGH). MAIZE YIELDS HAVE RISEN FROM 3 TONNES PER HECTARE TO 5 TONNES PER HECTARE. SOYA BEAN YIELDS ARE UP FROM 2.8 TONNES PER HECTARE TO 4.7 TONNES PER HECTARE.[90]

"High-yielding Green Revolution crops were introduced in poorer countries to overcome famine. But these are now blamed for causing intellectual deficits, because they do not take up essential micronutrients."

Dr Christopher Williams, research fellow with the Global Environmental Change Programme.[91]

3.2 Questioning the effectiveness of GM micronutrient-enhanced crops

GM pro-vitamin A rice is just one of the examples of 'functional' GM crops that are being promoted as the solution to micronutrient deficiencies in Southern countries. However, these developments do not address fundamental social and economic issues that lie at the root of micronutrient deficiencies.

They also do not address issues such as the loss of dietary diversity; replacement of foods such as legumes (higher in proteins, vitamins and minerals) by grains which are less nutritious; loss of diversity of grains, loss of "weed" plants through herbicide use that were formerly valuable sources of vitamins and minerals; loss of access to land to grow food for household food security.

Talk of GM crops such as 'golden rice' distract from more appropriate, long-term solutions to micronutrient deficiencies, because they:

- Divert attention, research and funding from the real causes of malnutrition;
- Ignore the need for dietary diversity reinforcing other diet related deficiencies;
- Undermine political will to implement affordable and sustainable measures to combat malnutrition

DOUBLE DUNG CURBS HUNGER IN KENYA

A SUSTAINABLE AGRICULTURE TECHNIQUE CALLED 'NEAR NIL INVESTMENT' IS SUPPORTED BY THE UK GOVERNMENT'S DEPARTMENT FOR INTERNATIONAL DEVELOPMENT (DFID). THE PRINCIPLE IS THAT POOR RURAL FAMILIES DO NOT HAVE THE FINANCIAL RESOURCES TO INVEST IN FARM IMPROVEMENTS, AND SO THEY NEED CHEAP WAYS TO BOOST PRODUCTIVITY. 'DOUBLE DUNG' BEDS - SEVEN- BY TWO-METRE PATCHES OF FIELD TURNED OVER INTENSIVELY WITH ORGANIC MANURES - ARE COMBINED WITH COMPOSTING, GREEN AND ANIMAL MANURES, PRODUCING BEDS WITH BETTER WATER-HOLDING CAPACITY THAT ARE ABLE TO SUSTAIN VEGETABLE GROWTH THROUGHOUT THE DRY SEASON. OF 5,000 FAMILIES INVOLVED, 75% OF HOUSEHOLDS ARE ENTIRELY FREE FROM HUNGER DURING THE YEAR.

Work of the Association for Better Land Husbandry, Kenya.[92]

"Trade liberalisation in agriculture has come to mean control over land, water, and biodiversity including: seed production and supply systems shifting from the farmer to corporate monopolies; contract farming enslaving the farmer to agribusiness monopolies; production of export-oriented cash crops replacing production of food crops; food prices controlled by international market forces and transnational corporations rather than by farmers or consumers, as well as the dismantling of food entitlement for consumers through the dismantling of laws. All these trends portend but one future for the people of India: loss of food security and imminent trade-created famines."

Vandana Shiva, Radha Holla and Kusum Menon,
Globalisation of agriculture and rising food insecurity.[93]

"A third of the world's 800 million hungry live in India [...] Year after year, the governments have managed a sizeable buffer stock essentially by depriving the poor of their basic human right - food. In 1999, India had produced a bumper harvest of wheat, some six million tonnes more than it produced a year before. Aware that at least 250 million people were going to bed hungry every night, still the government had allowed the surplus stocks to be exported. People die of starvation and hunger for the simple reason that they cannot afford to buy the food they produce."

Devinder Sharma, food and trade policy analyst, President of the Forum for Biotechnology and Food Security, New Delhi, India.[94]

4 Is GM research and patents addressing poverty and hunger in Southern countries?

4.1 Claim: GM research is meeting the needs of the South

Far from focusing on the needs of poor and vulnerable people in Southern countries, GM crop development is driven by the commercial interests of Northern companies. The major GM crops currently being grown - soya (63%), maize (19%), cotton (13%) and canola (5%)[95] - are largely designed to support the food and textile industry in the North, reflecting the economic imperative for biotechnology companies to gear their research towards markets that are likely to generate the largest profit. There is little financial incentive for GM research and development by private companies on staple food crops vital to developing countries.

The greatest acreage of GM crops grown in 2001 was destined primarily to feed animals for the Northern meat market. Although production of GM animal-feed crops for export to Northern markets generates export earnings for developing countries, the impact on poverty and food security depends on whether poor farmers are involved in export production and on what terms, and on the social, environmental and public health impacts of GM crop production. Since large commercial farmers are most likely to be able to afford the seeds and inputs needed to grow GM crops, they are most likely to derive the economic returns from GM export crop production.

GM crops in development also threaten vital markets for Southern exports. In many Southern economies agriculture makes a major contribution to Gross Domestic Product (GDP), as well as export revenue and employment. But GM technology is now offering Northern countries the opportunity to grow crops that can substitute for those currently grown in the South (such as plant oils, sugar and flavourings).[96] This has the potential to destroy vital export markets with serious implications for employment and food security in the South. For example, production of high-laurate oilseed rape threatens to undermine palm oil production vital to the economies of Malaysia and Indonesia.[97]

Crops such as oilseed rape can be modified to produce an altered oil composition (useful for soap manufacturers) which could displace palm and coconut oil producers in the developing world. One example is a Du Pont patent for an oilseed rape enzyme which alters the level of

INTEGRATED PEST MANAGEMENT IN BANGLADESH

EDUCATION IS THE KEY TO THE SUCCESS OF AN INTEGRATED PEST MANAGEMENT PROGRAMME IN BANGLADESH. IN A PROJECT SUPPORTED BY DFID AND THE EU, LOCAL FARMERS ATTEND WEEKLY FARMER FIELD SCHOOLS ('SCHOOLS WITHOUT WALLS') DURING A WHOLE RICE SEASON. THERE THEY LEARN NEW PRINCIPLES, CONCEPTS AND TERMS RELATING TO RICE, PEST AND PREDATOR MANAGEMENT. FARMERS HAVE BENEFITED IN SEVERAL WAYS: MOST HAVE REDUCED OR STOPPED USING PESTICIDES WITH NO LOSS OF RICE YIELD, THUS CUTTING THE COST OF PRODUCTION. THEY RAISE FISH IN THE RICE FIELDS THAT PROVIDE A NEW SOURCE OF PROTEIN AND INCOME, AND VEGETABLES ARE GROWN ON PADDY FIELD DIKES. AS A RESULT, 150,000 PARTICIPATING HOUSEHOLDS ARE NOW FOOD SECURE THROUGHOUT THE YEAR WHERE ONCE THEY WERE FOOD INSECURE FOR THREE TO FIVE MONTHS ANNUALLY.

Work of the Integrated Pest Management Programme, Bangladesh.[98]

"Areas sown with GM crops in the South are not designed to solve problems of food security but for export. The fact that farm land is dedicated to produce food for others, with all the risks brought by these crops, raises the question: which is most important for a country, foreign currency, or national food sovereignty."

Elizabeth Bravo, Accion Ecologica, Ecuador, 'Biodiversidad, Los Cultivos Transgenicos y Productos de Exportacion'.[99]

"Our food system takes abundant grain, which hungry people can't afford, and shrinks it into meat, which better-off people will pay for."

Frances Moore Lappé, author of Diet for a Small Planet. [100]

palmitic and stearic acid. The intention is to use the gene in soybean which will then be useful as a cocoa butter substitute. Thus cocoa producers may find they lose their high value market for cocoa butter.[101]

> *"We are looking for the genes that control the synthesis of natural rubber that would enable us to use plants commonly grown in this country as a source of that material."*
>
> Chad Holliday Chairman & CEO, DuPont.[102]

4.2 Claim: Current global patent rules balance public and private interests, including those of the poor and hungry

Patents, as enshrined in the World Trade Organisation's Trade Related Aspects of Intellectual Property Rights (TRIPs) Agreement, are designed to reward innovation by preventing others from exploiting the invention for 20 years. There is currently great pressure on all WTO member countries to allow the patenting of plant and animal genetic resources, genes and cells.

Patents are expensive to obtain and to defend against violation, giving wealthy transnational corporations and industrialised countries with strong financial markets a clear advantage in the process of gaining monopoly rights over the natural resources that have been used and developed by Southern farmers and communities over centuries. This 'biopiracy' is widely denounced in the biodiversity-rich Southern Hemisphere.

The Union for the Protection of New Varieties of Plants (UPOV) developed Plant Variety Protection laws, usually called Plant Breeders' Rights, give breeders the right to collect royalties from the sale of seed. Until 1991 farmers retained the right to keep seed from their harvest for re-sowing. But in 1991, the UPOV law was revised, bringing it in line with patent law. Under the new UPOV, Farmers must pay royalties on seeds and may not sell their harvest. Increasingly they may even be prevented from saving and exchanging seed. Southern countries are under great pressure to sign up to UPOV, the most recent version of which allows for the patenting of plant varieties.[103]

Patenting and genetic engineering reinforce each other. Genetic engineering provides the 'inventive step' required to gain patent control over a crop; patents provide the means to monopolise the profits on the 'invention' for the duration of the patent. Given the current legal frameworks and the power of transnational

HILLSIDE IMPROVEMENT IN HONDURAS AND GUATEMALA

ABOUT 45,000 FARM FAMILIES IN HONDURAS AND GUATEMALA HAVE SEEN INCREASING CROP YIELDS FROM 400-600KG PER HECTARE TO 2,000-2,500KG PER HECTARE. FARMERS HAVE BEEN ENCOURAGED TO USE GREEN MANURES, COVER CROPS AND CONTOUR GRASS STRIPS, IN-ROW TILLAGE, ROCK BUNDS (EMBANKMENTS) AND ANIMAL MANURES. THESE PROGRAMMES HAVE REGENERATED LOCAL ECONOMIES AND ATTRACTED PEOPLE TO RETURN TO RURAL AREAS FROM THE CITIES. IN ADDITION, FARMERS SAY THEY NO LONGER NEED TO CUT THE FORESTS, AS THEY HAVE THE TECHNOLOGIES TO FARM PERMANENTLY THE SAME PIECE OF LAND. THESE CONSERVED LANDS SUFFERED THE LEAST DURING HURRICANE MITCH IN NOVEMBER 1998, WITH THE TORRENTIAL RAINS ABSORBED BY THE CONSERVED SOILS RATHER THAN CAUSING LANDSLIDES.[104]

"One of the key factors in agricultural production has always been the control of the planting material. With TNCs controlling seed production, governments will tend to support its nationwide use and offer transgenic [GM] seeds as part of a package of technology, alongside inputs for machinery, fertilisers, pesticides, irrigation and production loans. Such an approach will choke rights of farmers to save their own seed and even control production in their own fields."

MASIPAG Farmer/Scientist Partnership for Development, Philippines.[105]

"Controls over plants and animals through patenting will largely determine who controls the food system in the future."

CIDSE (International Co-operation for Development and Solidarity,
Bio-patenting and the Threat to Food Security.[106]

corporations, patents and GM technology together:

- Promote private monopoly control over genetic resources, destroying diversity and eroding farmer's rights;
- Promote the adoption of new technologies (often seed/chemical packages), which may exacerbate indebtedness and poverty.[107]

Basmati Rice

In 1997, the Texas-based company RiceTec Inc was granted a patent on their own line of Basmati rice. The variety on which RiceTec claimed its patent is derived from Indian Basmati crossed with other native varieties developed by Asian farmers over many years. RiceTec's patent claims this derivation as an invention. By doing so, RiceTec threatens the export market of the very farmers who have grown and bred the rice varieties in India and Pakistan over many generations.[108]

Patents increase costs for the farmer and shift power and control from the farm to the corporation boardroom, for example:

- Farmers purchasing Monsanto's GM seeds in the US have to pay a technology fee and royalties on top of the price.[109] Farmers are not allowed to keep seed to replant but must purchase afresh each year. Many GM seeds are designed as part of a package including herbicides which have been patented by biotechnology companies eg: Monsanto's RoundUp ready soya.
- Knowledge nurtured over generations is appropriated and patented by companies, transforming shared indigenous knowledge into an expensive commodity.[110]

Patents distort the research agenda and limit research for the public good by:

- Encouraging research only in areas where patents are obtainable and profits assured;
- Restricting information sharing, because the invention must not be divulged before a patent application has been filed
- Increasing costs for research and new products (patent and licence fees are costly and litigation is frequent between companies);
- Making it legally complex and thus difficult and expensive to develop new varieties which will increasingly involve using patented genes.

4.3 Terminator and Traitor Technologies

GM technologies are now being developed to exclude farmers from control over seeds and crops. They are specifically designed to protect profits and not to improve agriculture. For instance:

- Contrary to promises made in 1999 by AstraZeneca and Novartis not to develop terminator style technology, and regardless of the FAO's statement that "the terminator seeds are generally unethical",[111] such a technology is still being pursued by the companies and patents are being granted.[112]

".... We consider the use of the South's rural poverty to justify the monopoly control and global use of GM food production by the North's transnational corporations, not only an obstructive lie, but a way of derailing the solutions to our Southern rural poverty."

From the Joint Letter to Channel Four Television and the Times Newspaper, UK, signed by 42 Southern Organisations.[113]

"....increased food supply does not automatically mean increased food security for all. What is important is who produces the food, who has access to the technology and knowledge to produce it, and who has the puchasing power to acquire it."

Jules Pretty and Rachel Hine. Feeding the World with Sustainable Agriculture: A summary of new evidence.[114]

"The [Basmati rice] patent is a direct appropriation of traditional knowledge of Indian farmers. It reduces years of informal research, breeding and innovation to a pirated product patent."

Shivani Chaudhry, Research Foundation for Science, Technology and Ecology, New Delhi, India. [115]

- New GM applications in development include seeds with traits that can only be activated by the application of a specific chemical sold by the seed company. These are known as Genetic Use Restriction Technologies (GURTs) or Traitor Technology.[116]

CROP DIVERSITY: BEATING DISEASE AND INCREASING YIELD

The fungal disease rice blast is the scourge of Chinese rice production. A large-scale study in China, in Yunnan Province, has revealed a simple, sustainable and successful approach to controlling the disease. Farmers sowed rows of highly valued glutinous rice, a variety susceptible to rice blast, interspersed with a resistant variety. In comparison to monocropped rice, the blast was 94% less severe in the mixed cropping system, and the yield of glutinous rice was 89% greater. Within two years, farmers were able to abandon chemical fungicides. Yields approached 10 metric tonnes per hectare, among the highest in the world. The study has expanded to cover over 40,000 hectares and involves tens of thousands of farmers.[117]

5 Conclusion

At best, GM technology attempts to address the *symptoms* and not the causes of hunger. The fundamental reason why hunger persists relates to the fact that poor people lack money to buy food that is readily available or that they are deprived of access to, control over or ownership of the productive resources necessary to produce it themselves. To implement effective and sustainable solutions to world hunger will require political and financial will on the part of national governments and international institutions. These solutions lie in better access to resources, improved education, employment, health, environmental policies and sustainable agricultural practices.

The claims that GM crops will end hunger by increasing agricultural yields are as yet unproven, untested, and perpetuate the myth that hunger is caused by scarcity of food. To the extent that GM technology, as an extension of the most intensive and industrialised methods of farming, contributes to increasing inequities in distribution of food and income, it may actually contribute to hunger.

The biotechnology industry promises technical solutions to the problem of micronutrient malnutrition with crops engineered to contain enhanced levels of vitamins and minerals. The most highly publicised of these crops, GM Vitamin A enhanced rice, is unlikely to address the problems of Vitamin A deficiency because it does not address fundamental social and economic issues that are at the root of micronutrient deficiencies. Furthermore, the promise of a 'quick-fix' technical solution threatens to divert attention from more appropriate long-term solutions.

Far from focusing on the needs of poor and vulnerable people in Southern countries, GM crop development is driven by the commercial interests of Northern companies. There is little or no financial incentive for research and development by private companies into GM research on staple food crops prevalent in developing countries. Patenting and genetic engineering reinforce each other. The current global patent rules and the power of transnational corporations promote monopoly control over genetic resources, destroying diversity and eroding farmer's rights.

As Gordon Conway, agricultural ecologist and President of the Rockefeller Foundation has pointed out, the priorities for future technological developments in agriculture must be to produce more food:

- At less cost;
- With less environmental damage;
- Which creates employment and income opportunities for the landless;
- And with pricing, marketing and distribution that ensure that the poor benefit.[118]

As illustrated by the many examples provided throughout this report, experience with non-chemical pesticides, integrated pest management, and organic and sustainable agriculture demonstrates that there are viable alternatives.

Members of the Five Year Freeze are calling for a minimum five year moratorium on:

- The growing of genetically-engineered crops for any commercial purpose
- Imports of genetically-engineered foods and farm crops
- The patenting of genetic resources for food and farm crops

Some members are against any research into GM crops. Others do not deny that GM technology offers potential to contribute to higher yields and crop productivity of interest to poor farmers if public and private funds are dedicated to addressing the real issues of concern. All members agree that the claims that current GM research initiatives will lead to the eradication of world hunger are over-stated and divert attention from the economic and policy decisions needed to address the fundamental causes of world hunger.

6 Resources

- *Food for Beginners* (1982): Susan George and Nigel Paige Readers and Writers, London
- *World Hunger: Twelve Myths* (1998): Lappé, Collins and Rosset, Earthscan, London
- *How the Other Half Dies, the real reasons for World Hunger* (1976/1991): Susan George, Harmondsworth, Penguin.
- *The Doubly Green Revolution: Food for all in the 21st century* (1997): Gordon Conway, Harmondsworth, Penguin
- *Genetic Engineering, food and our Environment* (1999): Luke Anderson, Green Books, Devon
- *Biopiracy: The Plunder of Nature and Knowledge* (1998): Vandana Shiva, Green Books, Devon
- *Agri-culture, Reconnecting People Land and Nature* (2002): Jules Pretty, Earthscan, London
- *Greenscapes, The Ecology of Genetic Engineering* (2002): Stephen Nottingham, Zed Books, London
- *Selling Suicide: farming, false promises and genetic engineering in developing countries* (May 1999): Andrew Simms, Christian Aid
- *Transgenic Plant and World Agriculture* (July 2000): The Royal Society, London.
- *Biotech - The Next Generation, Good for Whose Health?* (April 2000): The Food Commission and GeneWatch UK.
- *GM Crops: Food Production and World Hunger* (June 2000): UNISON, London.
- *Trade and the Hungry: how international trade is causing hunger* (August 1999): ed. John Madeley, APRODEV.
- *Genetically Modified Crops, World Trade and Food Security* (November 1999): Oxfam GM Policy Paper
- *Food? Health? Hope? Genetic Engineering and World Hunger* (October 1998): The Cornerhouse
- *Overfed and Underfed* (March 2000): Gary Gardner and Brian Halweil, Worldwatch Institute

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Christian Aid works in over 60 countries helping people regardless of religion or race, to improve their own lives and tackle the causes of poverty and injustice.

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A non-profit, public interest organisation dedicated to education about the environment, technology, and intellectual property rights.

ETC (ACTION GROUP ON EROSION TECHNOLOGY AND CONSERVATION) [PREVIOUSLY RAFI]

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ETC is an international non-governmental organisation dedicated to the conservation and sustainable improvement of agricultural biodiversity, and to the socially responsible development of technologies useful to rural societies.

FIVE YEAR FREEZE

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A coalition of UK based organisations calling for a moratorium on the commercial growing, importing and patenting of genetic engineering in food and farming.

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The Institute for Food and Development Policy, Food First, is a member-supported, non-profit 'peoples' think tank and education-for-action center. Our work highlights root causes and value-based solutions to hunger and poverty around the world, with a commitment to establishing food as a fundamental human right.

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Friends of the Earth, the UK's most influential national environmental campaigning organisation, inspires solutions to environmental problems, which make life better for people.

THE GAIA FOUNDATION

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The Gaia Foundation aims to protect cultural and biological diversity through supporting grass-roots projects in Africa and Amazonia, and by increasing civil society capacity and involvement in policy around key issues.

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Promotes the sustainable management and use of agricultural biodiversity based on people's control over genetic resources and local knowledge with special emphasis on developing countries.

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MASIPAG and its partners (farmers, scientists and NGOs) are concerned by the increasing presence of genetically modified crops and related products on the agricultural scene worldwide.

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Oxfam GB is a development, relief, and campaigning organisation dedicated to finding lasting solutions to poverty and suffering around the world.

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Pesticide Action Network Asia and the Pacific (PAN Asia and the Pacific). is dedicated to ensuring the empowerment of people, especially women, agricultural workers, farmers and peasants. We are specially committed to protect the safety and health of people and the environment from pesticide use.

THIRD WORLD NETWORK
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The Third World Network is an independent non-profit international network of organisations and individuals involved in issues relating to development, the Third World and North- South issues.

8 References

1 Coghlan, A., *Filling the Bowl* in *New Scientist*, London: Reed Publications, 1 April, 2000.

2 FAO, *The State of Food Insecurity in the World,* Rome: Food and Agriculture Organisation of the UN, 1999.

3 Statement from all the African delegates (except South Africa) to FAO negotiations on the International Undertaking for Plant Genetic Resources, *Let Nature's Harvest Continue*, June, 1998.

4 Akhtar, F., Personal communication, Bangladesh: UBINIG, Policy Research for Development Alternatives, 8 September 2000.

5 Prakash, C. S., From the essay 'Feeding a world of six billion', Ag Bio Forum, Summer/Fall, 1999.

6 Bravo, E., Personal communication, 'Biodiversidad, Los Cultivos Transgenicos y Productos de Exportacion', Ecuador: Accion Ecologica, 2000.

7 Definition according to the Committee on World Food Security of the UN, Food and Agriculture Organisation, 1995.

8 Cited in: Pearce, F., *An Ordinary Miracle*, in *New Scientist*, London: Reed Publications, 3 February, 2001.

9 MASIPAG, Special edition of *Suhay*, the official newsletter of MASIPAG, May 2000.

10 Simms, A., *Selling Suicide: farming, false promises and genetic engineering in developing countries"*, London: Christian Aid, May 1999.

11 Sharma, D., Personal communication. New Delhi, India: Forum for Biotechnology and Food Security, 2000.

12 World Bank, *World Development Report 2000/2001*, Oxford: World Bank/Oxford University Press, 2000/01; FAO, *The State of Food Insecurity in the World*, Rome: Food and Agriculture Organisation of the UN, 1999.

13 World Bank, 2000/01, op. cit.; Madeley, J., *Hungry for Trade,* London: Zed Books, 2000.

14 Conway, G., *The Doubly Green Revolution: Food for all in the 21st century*, London: Penguin, 1997.

15 World Bank, 2000/01, op. cit.

16 Kendall, H. W. et al., *Bioengineering of Crops: Report of the World Bank panel on Transgenic Crops*, International Bank for Reconstruction and Development, Washington DC, USA: World Bank, 1997.

17 Monsanto, *1997 Report on Sustainable Development, including Environmental, Safety and Health Performance*, St Louis, USA: Monsanto, March 1998.

18 Dubock, A., executive from Zeneca (now Syngenta), *Extract from a speech delivered at the conference Sustainable Agriculture in the New Millennium*, Brussels, Belgium, May, 2000.

19 Monsanto, March 1998, op. cit.

20 Cited in: Pearce, F., *An Ordinary Miracle, in New Scientist*, London: Reed Publications, 3 February, 2001.

21 MASIPAG, Farmer/Scientist Partnership for Development Inc, *GE Rice: Asian Farmers have everything to Lose*, News & Views, Philippines, 2000.

22 Simms, A., May 1999, op. cit.

23 FAO, *World Agriculture: Towards 2015/30*, July, 2000, accessed at: www.fao.org/DOCREP/004/Y3557E/Y3557E00.HTM.

24 Pretty, J., *Feeding the world: Sustainable agriculture and genetic modification*, briefing paper. London: ActionAid, 2000.

25 Lutzenberger, J. A. and Halloway M., *The Absurdity of Modern Agriculture: From chemical fertilisers and agro-poisons to biotechnology,* revised edition, October 1998.

26 Conway, G., 1997, op. cit.

27 Rosset, P., *Now serving six billion empty stomachs in a land of plenty,* in *The San Francisco Chronicle,* USA, 15 August, 1999.

28 FAO, Report press release, Rome: Food and Agriculture Organisation of the UN, 14 July, 2000.

29 FAO, *World Agriculture: Towards 2015/30,* July 2000, op. cit.

30 FAO, World *Agriculture: Towards 2015/30, Technical Interim Report, April 2000*, Rome: Food and Agriculture Organisation of the UN, Economic and Social Department, 2000.

31 Nord, M.; Kabbani, N.; Tiehen, L.; Andrews, M.; Bickel, G. and Carlson, S., *Household Food Security in the United States, 2000*, Economic Research Service, US Department of Agriculture (USDA), March 2000.

32 Sustain: the alliance for better food and farming, *Food with Latitude: A report exploring food projects links across the North-South divide*, Sustain: the alliance for better food and farming, London, June 2002.

33 Lappé, F. M.; Collins, J. and Rosset P., with Luis Esperanza, *World Hunger: Twelve Myths,* London: Earthscan, second revised and up-dated version, 1998.

34 Gardner, G. & Halweil, B., *Overfed and Underfed: The global epidemic of malnutrition*, Washington DC, USA: Worldwatch Institute, March 2000.

35 Simms, A., May 1999, op. cit.

36 The World Bank, *Poverty and Hunger*, 1986, cited in Lappé, F. M.; Collins J.; Rosset, P., 1998, op. cit.

37 Pretty, J., *Regenerating Agriculture: Policies and practice for sustainability and self-reliance*. London: Earthscan, 1995; FAO, *Report on the 1980 World Census of Agriculture*, Rome: Food and Agriculture Organisation of the UN, 1981; Hobbelink, H., *Biotechnology and the future of world agriculture*, London: Zed Books, 1991.

38 Cited in: Pearce, F., *An Ordinary Miracle, in New Scientist*, London: Reed Publications, 3 February, 2001.

39 Conway, G., 1997, op. cit.

40 Conway, G., 1997, op. cit.; Pretty, J., 1995, op. cit.

41 Benbrook, C. (former Executive Director of the Board on Agriculture for the US National Academy of Sciences), *Evidence of the magnitude and consequences of the Roundup Ready soybean yield drag from university-based varietal trials in 1998*, Ag BioTech InfoNet Technical Paper Number 1, July 1999.

42 United States Department of Agriculture, *Genetically engineered crops for pest management*, Washington DC, USA: USDA Economic Research Service, 1999.

43 Fox, J., *Farmers say Monsanto's engineered cotton drops bolls*, in *Nature Biotechnology,* 15:1233, 1997; Fox, J., *A few farmers wrangle over engineered cotton*, in *Nature Biotechnology,* 16:414, 1998.

44 Gertz, J. M.; Vencill, W. K.; and Hill, N. S., *Tolerance of transgenic soybean (*Glycine max*) to heat stress,* Paper given at The 1999 Brighton Conference of the British Crop Protection Council, 1999; Also: Coghlan, A., *Monsanto's modified soya beans are cracking up in the heat: Splitting headache,* in *New Scientist*, London: Reed Publications, 20 November, 1999; Hatchwell, P., *Opening Pandora's Box: The risks of releasing genetically engineered organisms*, in *The Ecologist* 19(4), pp. 130-136, London, 1989.

45 FAO, *The State of the World's Plant Genetic Resources for Food and Agriculture*, FAO, Rome, 1998; ODI, *The erosion of crop genetic diversity: Challenges, strategies and uncertainties*, Overseas Development Institute, March, 1996.

46 Shiva, V., *Staying Alive*, London: Zed Books, 1989; Conway, G., 1997, op. cit.

47 Conway, G., 1997, op. cit.

48 Williams, C., *Terminus Brain: The Environmental Threats to Human Intelligence*, Cassell: London and Washington, 1997.

49 Conway, G., 1997, op. cit.

50 Cited in: Pearce, F., *An Ordinary Miracle*, in *New Scientist*, London: Reed Publications, 3 February, 2001.

51 New Scientist, London: Reed Publications, 8 July 2000.

52 Conway, G., 1997, op. cit.

53 Conway, G., 1997, op. cit.

54 Conway, G., 1997, op. cit.; Simms, A., May 1999, op. cit.

55 Conway, G., 1997, op. cit.

56 Pretty, J., *Feeding the world: Sustainable agriculture and genetic modification*, briefing paper. London: ActionAid, 2000.

57 Cited in Simms, May 1999, op cit.

58 Tansey, G., *Trade, Intellectual Property, Food and Biodiversity: A discussion paper*, London: Quaker Peace and Service, 1999.

59 Gould, F., *Potential problems with high-dose strategies for pesticidal engineered crops*, *Biocontrol Science and Technology* (4)451-461, 1994.

60 Malone, L. A.; Burgess, E. P. J.; Christeller, J. T.; Gatehouse, H. S., *In vivo responses of honey bee midgut proteases to two protease inhibitors from potato*, in *Journal of Insect Physiology*, 44(2):141-147, 1998; Burgess, E. P. J.; Malone, L. A.; Christeller, J. T., *Effects of two proteinase inhibitors on the digestive enzymes and survival of honeybees (*Apis mellifera), in *Journal of Insect Physiology* 42(9):823-828, 1996.

61 Raffa, K. F., *Genetic engineering of trees to enhance resistance to insects*, in *Bioscience* 39(8):524-535, 1989.

62 Jewell, T., *Glyphosate, Pesticide News*, 33:5, London: Pesticides Trust (now Pesticides Action Network UK), 1996; Steinbrecher, R.A., *Ecological Consequences of Genetic Engineering*, in Tokar B. (edited by), *Redesigning Life? The Worldwide Challenge to Genetic Engineering*, London: Zed Books, 2001; Smiley, R. W., *Influence of glyphosate on Rhizoctonia root rot, growth and yield of barley*, *Plant Disease,* (76): 937-942, 1992; Holmes, M. T.; Ingham, E. R.; Doyle, J. D.; Hendricks, C. W., *Effects of* Klebsiella planticola SDF20 *on soil biota and wheat growth in sandy soil*, in *Applied Soil Ecology,* (326): 1-12, 1998; Physicians and Scientists for Responsible Application of Science and Technology (PSRAST), *Genetically Engineered Crops - A Threat to Soil Fertility?* , PRAST, 2001.

63 National Coalition for Alternatives to Pesticides (NCAP), *Herbicide Factsheet: Glyphosate (Roundup)*, in *Journal of Pesticide Reform*, vol. 18, no. 3, 1998; Altieri M.A., *Genetic Engineering in Agriculture: The Myths, Environmental Risks, and Alternatives*, Food First Special Report no. 1, Oakland, California,

2000; Bidwell, J. R.; Gorrie, J. R., *Acute toxicity of a herbicide to selected frog species*, Final Report prepared for the Western Australian Department of Environmental Protection, Perth, Western Australia, 1995; Carlisle, S. M. and Trevor, J.T., *Glyphosate in the Environment, Water Soil and Air Pollution,* (39):409-420, 1988, Cited in *Pesticides News,* 33, Pesticides Trust: London, UK, September 1996.

64 Hawaii Tribune-Herald, *Big Isle papaya crops tainted,* Front Page, 7 April 2000; Simon, A. E.; Burjaski, J. J., *RNA recombination and evolution in virus-infected plants*, in *Annual Reviews of Phytopathology*, (32):337-362, 1994; Zhou, X.; Liu, Y.; Calvert, L.; Munoz, C.; Otim-Nape, G. W.; Robinson, D. J.; Harrison, B. D., *Evidence that DNA-A of a geminivirus associated with severe cassava mosaic disease in Uganda has arisen by interspecific recombination*, in *Journal of General Virology,* (78):2101-2111, 1997; Király, L.; Bourque, J. E.; Schoelz, J. E., *Temporal and spatial appearance of recombinant viruses formed between cauliflower mosaic virus (CaMV) and CaMV sequences present in transgenic* Nicotiana bigelovii, in *Molecular Plant-Microbe Interactions,* 11(4):309-316, 1998; Greene, A., Allison, R. F., *Recombination between viral RNA and transgenic plant transcripts*, in *Science,* 263:1423-1425, 1994; Lommel and Xiong, *Reconstitution of a functional red clover necrotic mosaic virus by recombinational rescue of the cell-to-cell movement gene expressed in a transgenic plant*, in *Journal of Cell Biochemistry*, 15A: 151, 1991; Schoelz, J. E.; Wintermantel, W. M., *Expansion of viral host range through complementation and recombination in transgenic plants*, in *Plant Cell,* 5:1669-1679, 1993; Wintermantel, W. M.; Schoelz, J. E., *Isolation of recombinant viruses between cauliflower mosaic virus and a viral gene in transgenic plants under conditions of moderate selection pressure*, in *Virology*, 223:156-164, 1996; Vance, V. B.; Berger, P. H.; Carrington, J. C.; Hunt, A. G.; Shi, X. M., *5-proximal potyviral sequences mediate potato-virus-x potyviral synergistic disease in transgenic tobacco*, in *Virology*, 206:583-590, 1995; Lecoq, H.; Ravelonandro, M.; Wipf-Scheibel, C.; Monsion, M.; Raccah, B.; Dunez, J., *Aphid transmission of a non-aphid transmissible strain of zucchini yellow potyvirus from transgenic plants expressing the capsid protein of plum pox potyvirus*, in *Molecular Plant-Microbe Interactions,* 6:403, 1993; Asins, M. J.; Monforte, A. J.; Mestre, P. F.; Carbonell, E. A., *Citrus and Prunus copia-like retrotransposons*, in *Theoretical and Applied Genetics*, 99(3-4):503-510, 1999.

65 Benbrook, C.M., *Troubled Times Amid Commercial Success for Roundup Ready Soybeans: Glyphosate Efficiency is Slipping and Unstable Transgene Expression Erodes Plant Defences and Yelds*, Sandpoint, Idaho: Northwest Science and Environmental Policy Center, AgBiotech InfoNet Technical Paper No 4, 3 May, 2001; English Nature, *GM crops may become weedier*, English Nature news release, 2 February 2002.

66 Belsie, L., *An Unstoppable Technology? Behind the Biotech Push: World hunger*, in *The Christian Science Monitor,* October, 2000.

67 ETC group (formerly RAFI), *Ag Biotech Countdown: Vital Statistics and GM Crops, Update—June, 2002*, ETC Group: Canada, June, 2002.

68 Bruce, D. and Bruce, A., *Engineering Genesis: The ethics of genetic engineering in non-human species*, London: Earthscan, 1998.

69 FAO press release, 96/9 *State of the World's Plant Genetic Resources*, Rome: Food and Agriculture Organisation of the UN, 1996.

70 Simms, A., May 1999, op. cit.

71 Pretty, J., *Feeding the world: Sustainable agriculture and genetic modification*, briefing paper. London: ActionAid, 2000.

72 Egziabher, T., *Fighting Back,* in *New Scientist*, London: Reed Publications, 20 January 2001.

73 Dunham, W., *USA: Salt-Tolerant Tomato Represent Breakthrough*, Washington: Reuters, 30 July 2001.

74 The Cornerhouse, *Food? Health? Hope? Genetic Engineering and World Hunger*, Dorset: Cornerhouse, October 1998.

75 PAN-AP, *Pesticide Monitor*, Vol 6 No 2, July 1997.

76 Pretty, J., *Feeding the world: Sustainable agriculture and genetic modification*, briefing paper. London: ActionAid, 2000.

77 Akhtar, F., Personal communication, Bangladesh: UBINIG, Policy Research for Development Alternatives, 8 September 2000.

78 Padulosi, S., *Opinion Interview* in *New Scientist*, pp 42-45, London: Reed Publications, 2 September 2000.

79 Gardner, G.; Halweil, B., *Overfed and underfed: The global epidemic of malnutrition*, Worldwatch Paper 150, Washington DC, USA: Worldwatch Institute, March, 2000.

80 Dubock, A., May 2000, op. cit.

81 World Health Organisation (WHO), *Vaccines, Immunization and Biologicals. Vitamin A Deficiency,* WHO, 2001.

82 Dubock, A., May 2000, op. cit.

83 Brown, P., 10 February 2001, op. cit.

84 World Health Organisation website: www.who.int/vaccines-diseases/diseases/vitamin_a.shtml.

85 Brown, P., *GM Rice Promoters "Have gone too far"*, in *The Guardian*, London, 10 February, 2001.

86 Brown, P., 10 February 2001, op. cit.

87 Shiva, V., *The 'Golden Rice' Hoax - When Public Relations Replaces Science,* October, 2000.

88 Nestle, M., *Genetically Engineered 'Golden Rice' is Unlikely to Overcome Vitamin A Deficiency,* Letter to the Editor, *Journal of American Dietetic Association,* Vol. 101, March 2001.

89 Dubock, A. (executive of Syngenta), Personal correspondence by email, January 2001.

90 Pretty, J., *Feeding the world: Sustainable agriculture and genetic modification*, briefing paper. London: ActionAid, 2000.

91 Cited in Lean, G., *Hi-tech crops are bad for the brain*, in *The Independent*, London, 23 April 2000.

92 Pretty, J., *Feeding the world: Sustainable agriculture and genetic modification*, briefing paper. London: ActionAid, 2000.

93 Shiva, V.; Holla, R.; Menon, K., *Globalisation of Agriculture and the Growth of Food Insecurity: A Report of the International Conference on Globalisation, Food Security and Sustainable Agriculture, held in New Delhi,* July 1996.

94 Sharma, D., Personal communication, Forum for Biotechnology and Food Security: New Delhi, India, 2000.

95 ETC group, June 2002, op. cit.

96 The Cornerhouse, October, 1998, op. cit.

97 ETC Group (formerly RAFI), *Genetically Engineered High-Lauric Rapeseed (Canola): What Threat to*

Tropical Lauric Oil Producers, RAFI Communique, Winnipeg, Canada, 1995.

98 Pretty, J., *Feeding the world: Sustainable agriculture and genetic modification*, briefing paper. London: ActionAid, 2000.

99 Bravo, E., Personal communication, 'Biodiversidad, Los Cultivos Transgenicos y Productos de Exportacion', Ecuador: Accion Ecologica, 2000.

100 Cited in: Bello, W., *Cows Eat Better than People Do*, San Francisco, USA: The Institute for Food and Development Policy.

101 ActionAid, *Crops and Robbers: Biopiracy and the Patenting of Staple Food Crops*, ActionAid: London, 2000.

102 Holliday, C., Speech from the Chairman & CEO of DuPont, at the Boston Chief Executives Club, USA, September, 1999, www.dupont.com/biotech/resources/speeches/speeches_092299.html.

103 GAIA/GRAIN, *Ten reasons not to join UPOV*, in *Global Trade and Biodiversity in Conflict*, Issue No. 2, May, 1998, www.grain.org/publications/gtbc/issue2.htm.

104 Pretty, J., *Feeding the world: Sustainable agriculture and genetic modification*, briefing paper. London: ActionAid, 2000.

105 MASIPAG, *GE Rice: Asian Farmers have everything to Lose,* 2000, op. cit.

106 CIDSE, *Bio-patenting and the Threat to Food Security: A Christian and Development Perspective*, Executive Summary, February 2000, http://www.cidse.org/pubs/tg1ppexs.htm.

107 Conway, G., 1997, op. cit.

108 Browne, A., *India Fights Basmati Rice Patent,* 25 June, 2000, http://www.biotech-info.net.

109 Karnataka State Farmers Association, *Monsanto's Cremation Starts in Karnataka*, Institute for Global Communications, 1998.

110 GRAIN, *Patenting, Piracy and Perverted Promises: Patents on life: the last assault on the commons*, GRAIN: Barcelona, April 1998.

111 Panel of Eminent Experts on Ethics in Food and Agriculture of the Food and Agriculture Organisation of the United Nations (FAO), *Report of the Panel of Eminent Experts on Ethics in Food and Agriculture. First Session,* Rome: Food and Agriculture Organisation of the United Nations, 2001.

112 Warwick, H., *Syngenta: Switching off farmers' rights*, London: ActionAid, Genewatch UK, Swedish Society for Nature Conservation, Berne Declaration, October, 2000.

113 From the *Joint Letter to Channel Four Television and the Times Newspaper*, UK, signed by 42 Southern Organisations in protest to documentary, (Equinox, 19th March 2000) and Article (GM foods and the luxury of choice, 21st March 2000), using southern scientists to make Europeans feel guilty for not supporting genetic engineering, April 2000.

114 Pretty, J.; Hine, R., *Feeding the World with Sustainable Agriculture: A summary of new evidence*, University of Essex, 2000.

115 Chaudhry, S., *Basmati Biopiracy*, New Delhi, India, Research Foundation for Science, Technology and Ecology, 1998.

116 ETC group (formerly RAFI), *Traitor Technology: The terminator's Wider Implications*, RAFI Communique, 30 January, 1999.

117 Zhu, Youyong et al., *Genetic Diversity and disease control in Rice*, in *Nature*, Vol.406, London, 17 August, 2000.

118 Conway, G., 1997, op. cit.

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