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Hungry Corporations:

Transnational Biotech Companies Colonise the Food Chain

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Chapter 1:

In the Name of Hunger: Paving the Road to Biotech Agriculture

Food has long been a political tool in US foreign policy. Twenty-five years ago USDA Secretary Earl Butz told the 1974 World Food Conference in Rome that food was a weapon, calling it 'one of the principal tools in our negotiating kit'. As far back as 1957 US Vice-President Hubert Humphrey told a US audience, 'If you are looking for a way to get people to lean on you and to be dependent on you in terms of their cooperation with you, it seems to me that food dependence would be terrific.'

Rafael V. Mariano, chairperson of the Peasant Movement of the Philippines, 2000[1]

1.1 Prologue

At the 1974 UN World Food Conference in Rome governments adopted the Universal Declaration on the Eradication of Hunger and Malnutrition, proclaiming that 'every man, woman and child has the inalienable right to be free from hunger and malnutrition in order to develop their physical and mental faculties'.[2] The goal was to eradicate hunger, food insecurity and malnutrition within the next decade, and emphasis was placed on increasing food production, mainly by technical means and especially those developed as part of the 'green revolution'.

The global community failed to achieve its goal and, when governments reconvened in Rome in 1996 for the World Food Summit, 800 million people faced hunger and malnutrition. A Plan of Action that accommodated the interests of all participating countries was agreed and governments renewed their resolve: 'We pledge our political will and our common and national commitment to achieving food security for all and to an ongoing effort to eradicate hunger in all countries, with an immediate view to reducing the number of undernourished people to half their present level no later than 2015.'

At the same time governments stressed that the Summit was 'not a pledging conference' where governments come prepared to make actual financial commitments. It was instead a conference of non-binding commitments. Many NGO participants criticised the lack of positive undertakings and political will, and the failure to evaluate previous programmes and approaches. Furthermore, NGOs reported a growing bias towards solutions involving genetic engineering, predominantly led by US initiatives and backed by the public relations campaigns of the biotech industry. The Summit was an early target of the protests involving direct action that have since become a hallmark of the public response to genetically engineered food.

Five years later, the Rome-based Food and Agriculture Organisation (FAO) of the United Nations, recognising that the number of hungry people had remained the same and that the 1996 targets were not going to be met, decided to host yet another World Food Summit in 2002.[3] This time biotechnology was formally endorsed as a way to address hunger, not least because 'the US had been heavily pushing biotechnology as a solution to world hunger'.[4] Patrick Mulvany of the UK's Intermediate Technology Development Group (ITDG), an NGO participant, reported:

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> The US say they left the Food Summit happy: they had achieved acceptance of the term 'biotechnology' in the final declaration, with no reference to biosafety, the Cartagena Protocol or the Precautionary Principle; had deleted any reference to an international legally-binding Code of Conduct on the Right to Food; and had watered down the call to ratify the new International Seed Treaty … to something for countries 'to consider'.[5]

The declaration – prepared in long negotiations prior to the Summit and adopted in Rome by 180 countries – says: 'We are committed to study, share and facilitate the responsible use of biotechnology in addressing development needs.' Paragraph 25 further reads:

> We call on the FAO, in conjunction with the CGIAR [Consultative Group for International Agricultural Research] and other international research institutes, to advance agricultural research and research into new technologies, including biotechnology. The introduction of tried and tested new technologies including biotechnology should be accomplished in a safe manner and adapted to local conditions to help improve agricultural productivity in developing countries.[6]

During the six years between 1996 and 2002 the biotech industry had wasted no time in pushing genetically engineered food on to the market. To its bemusement, it had met with success in the US but opposition in Europe, and this setback had forced it to turn to advertising and public relations.

During the summer of 1998, the British media was treated to a £1 million advertising campaign from Monsanto, genetic engineering's most vocal proponent. This campaign was later criticised by the UK's Advertising Standards Authority, which ruled in July 1999 that Monsanto had used 'confusing' and 'misleading' claims. The public were told by Monsanto that 'worrying about starving future generations won't feed them' and 'slowing its [genetic engineering's] acceptance is a luxury our hungry world cannot afford'. The response from the FAO's African delegates was swift and damning. Calling on the corporations to 'Let Nature's Harvest Continue', they stated:

> 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 twenty-first 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. (FAO statement by 24 delegates from 18 African countries, 1998)

Underlying this debate are two very different approaches to world hunger. The first focuses narrowly on the seed and its genes – seeking to develop a few varieties that will provide high yields under monoculture conditions over vast areas. Such varieties are often called high-response varieties (HRVs), because in order to prosper they require inputs of pesticide, fertiliser and, often, irrigation. Such seeds are not adapted to local conditions but instead require conditions to be adapted to their own growing requirements. The only values considered are yields; the costs and impact of pesticides and fertilisers on soil, water, biological and agricultural diversity, and human health are discounted or externalised. The other approach considers that food insecurity is highly complex and requires careful analysis of the problems and possible solutions. Issues such as poverty, lack of access to land, water, seed and food, poor infrastructure and distribution, unsustainable farming practices, national debt, or wild fluctuations and inequalities in the world market are seen as more fundamental. They need political solutions rather than technical fixes, and approaches to research that see the farm as a complex ecological system. Crop yields are only a small part of the solution. Enough food is produced for everyone now, yet 800 million people are hungry, thus indicating that production levels are not the real problem.

Those who support the second view believe that genetic engineering will do nothing to address the underlying structural causes of hunger but could instead do much to exacerbate them. There are shades of grey between these two positions. Some commentators argue that genetic engineering of crops could be part of the solution if its agenda was not set by the corporations and limited by corporate control of patents. Gradually, corporate executives have begun to reflect this argument in their rhetoric, if not necessarily in their research and development (R&D) projects. They have toned down their claims from insisting that genetic modification (GM) is the solution to hunger, to presenting it as just one of the tools that can be used. For example, Steve Smith of Novartis Seeds (UK) made the following statement at a public meeting in Norfolk in March 2000:

> If anyone tells you that GM is going to feed the world, tell them that it is not ….To feed the world takes political and financial will, it's not about production and distribution. It is not the single answer; it is one of many areas that is being investigated. It may produce more for less and create more food but it won't feed the world.

Yet the reality is that the proponents of GM technology are still pushing GM crops as if they were the single answer to many problems. Moreover, opponents of GM point out that contamination problems alone may mean that in many areas coexistence between GM and non-

GM agriculture will prove impossible, ruling GM out as part of a diverse approach. Proponents counter by claiming that 'technology protection systems' such as 'genetic use restriction technologies' or GURTs, otherwise known as Terminator and Traitor technologies (see Chapter 8), can prevent contamination. Opponents point to the implications of saved seed which is sterile – and the arguments continue.

1.2 The green revolution

The green revolution myth goes like this: the miracle seeds of the green revolution increase grain yields and therefore are a key to ending world hunger. Higher yields mean more income for poor farmers, helping them to climb out of poverty, and more food means less hunger. Dealing with the root causes of poverty that contribute to hunger takes a very long time and people are starving now. So we must do what we can – increase production.

Rosset *et al*., 'Lessons from the Green Revolution', 2000[7]

The green revolution was a transformation of agriculture practice developed for the South by scientists, governments and donor agencies from the North. Essentially it involved the development of varieties of certain major crops – such as wheat, rice, and maize – that would, in response to higher inputs, produce higher yields. The Food and Agriculture Organisation itself admits: 'The green revolution of the 1960s and 1970s depended on applications of fertilisers, pesticides and irrigation to create conditions in which high-yielding modern varieties could thrive.'[8]

The first international agricultural research centres (IARCs), such as the International Rice Research Institute (IRRI) in the Philippines and the International Maize and Wheat Improvement Centre (CIMMYT) in Mexico, were established in the early 1960s with the help of the Ford and Rockefeller foundations (see Chapter 5). They promoted the idea that these new, uniform, high-response varieties (HRVs) could flourish anywhere, irrespective of local differences in conditions. This approach was also favoured by Robert S. McNamara, who moved from being president of the Ford Motor Company to become US Secretary of Defense and Vietnam War hawk, and who left the US administration to be president of the World Bank for 13 years (1968–81).[9] In 1971, the World Bank, the US and the FAO established the CGIAR, an informal group of Northern donors aiming to support a network of international agricultural research centres based in the South (see Chapter 5).

The green revolution was heralded both as the miracle path for economic development and as a necessity to meet the needs of the 'ever-growing' populations of the South. It was also quietly promoted as a means to stem the potential threat of communism[10] in South-east Asia and Central America, since persistent poverty and hunger were considered fertile ground for revolution.[11] Once the new HRVs (also called high-yielding varieties or HYVs) had been developed by the IARCs, a plethora of governments, extension workers, aid agencies and corporations specialising in chemicals and machinery gave incentives to small-scale and subsistence farmers to adopt this 'revolution' in agriculture. They were encouraged with free starter supplies of seeds, fertilisers or pesticides. Irrigation facilities were built, and loans and credit schemes were employed to encourage farmers to use the new hybrid seeds, pesticides and machinery. It was intended that the higher yields would give these farmers a surplus to sell, thus incorporating 'subsistence' farmers into the market economy.

To promote green revolution practices, governments designed their own measures, of which the following are just a sample:

- In the Philippines up to 1981, government loans were given solely to farmers who agreed to plant one of the ten government-approved HRVs.
- The Kenyan government forbids outreach workers to teach local farmers how to compost, and rather promotes the use of chemical fertilisers.[12]
- In Iran during the 1970s large landowners who mechanised their farms were exempt from a land reform act.[13]

Impacts of the green revolution

[I]t is also 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 fifteen tons of food per hectare and all without commercial fertilizers or pesticides and no assistance from banks or governments or transnational corporations.

José A. Lutzenberger and Melissa Holloway, 1998[14]

The conclusions of Lutzenberger and Holloway contrast with findings reported by the FAO. In a document ('Towards a New Green Revolution') produced for the 1996 World Food Summit, the FAO claims that

> The gains in production were dramatic: world cereal yields jumped from 1.4 tonnes per hectare in the early 1960s to 2.7 tonnes per hectare in 1989–91. Over the past 30 years, the volume of world agricultural production has doubled and world agricultural trade has increased threefold.[15]

However, the same report records that

> In order to reap the potential of the new seeds, farmers also rapidly increased their use of mineral fertilisers, pesticides and irrigation. Between 1970 and 1990, fertiliser applications in developing countries shot up by 360 per cent while pesticide use increased by 7 to 8 per cent per year. The amount of land under irrigation increased by one-third.

Although it undoubtedly increased yields of certain crop grains for a number of years, the green revolution had a wide range of negative impacts which, like the impacts of other new technologies, often did not appear until later. These included introducing hybrids at the expense of locally adapted 'farmer varieties', removing farmers from their land, forcing changes in practice and creating dependence on pesticides, fertilisers, petroleum and machinery. The costs of farming increased. Land was concentrated in the hands of fewer and fewer farmers. Water resources were depleted, while increased irrigation led to greater salinity and left large amounts of land unusable. Water, land and people's health were damaged by fertiliser and pesticide use.[16] Nutrient levels in soils and crops declined. Moreover pests and diseases, far from being eliminated, often increased. Finally, the green revolution helped transform agriculture into agribusiness, so paving the way for the entry of the corporations and their products.

The green revolution also transformed traditional farming cultures. Farmers, mostly women, have for thousands of years selected and saved seed to create literally thousands of 'farmer varieties' of food crops adapted to local conditions and preferences. As the green revolution spread across the South, the diversity that these farmers had nurtured was eroded. Farmer varieties could only survive in interaction with people and disappeared if not saved and planted. In the Indian state of Andhra Pradesh, one study found that the incursion of the green revolution led to a loss of 95 per cent of traditional rice varieties without their collection or documentation.[17] The FAO calculates that 75 per cent of India's rice production may now be planted with just 12 varieties. Communities also lost traditional sources of essential micro-nutrients and vitamins, such as vitamin A, in the form of plants that were considered weeds under the new regime and had to be eliminated.

The costs of farming increased, with serious impacts on smaller farmers. The need for expensive inputs and machinery gave bigger farmers an advantage, since either they could afford the required inputs or they found it easier to obtain credit. As large operators, they also benefited from economies of scale and were better able to survive profit squeezes brought about by increased costs or any fall in price for their products. This meant that smaller farmers were often driven off their land into the burgeoning cities of the South, so that instead of producing food, they swelled the numbers of people who depended on being able to purchase it – though often having scant means to do so. The bigger farmers therefore increased their landholdings and their strength, while the overall number of farmers fell.

However, the promised yields of the new varieties of crop were not always forthcoming. In order to try to emulate the high yields achieved at research stations, farmers sought to replicate the field-test conditions where the varieties were developed. In the words of one scientist from the IRRI, the new green revolution varieties led to 'sharp increases in the use of fertilisers and pesticides needed to ensure bumper harvests'.[20]

Sketch of an anti-revolutionary

R. H. Richharia, a famous Indian rice scientist, made a collection of more than 19,000 rice cultivars and examples of wild rice in the 1970s, which is now held at the Indira Gandhi Agricultural University (IGAU) in Raipur. He wrote lovingly about the diversity of varieties in Madhya Pradesh, and noted that many were high-yielding and resistant to pests. There is little irrigation in the region, which is often affected by drought.

He was director of the Central Rice Research Institute (CRRI), Cuttack, India as well as of the Madhya Pradesh Rice Research Institute (MPRRI). As Meena Menon noted in her article on rice varieties, 'He was removed from the CRRI as he opposed the dwarf varieties which were being brought into the country in 1966, as he felt they were highly susceptible to pests.'[18] Later, at a conference in Malaysia in 1986, 'Dr Richharia in a paper said "pressure was brought about by the World Bank to close the activities of this Institute [MPRRI] in lieu of offering a substantial financial assistance as I had refused to pass on the entire rice germplasm to IRRI without studying it"'.

In 2002, Syngenta failed in a bid to enter into an agreement with the IGAU to use the collection as raw material for developing its own products.[19]

However, from the outset farmers planting these varieties were unable to achieve the promised yields, lacking either the specific ecological conditions, the inputs or the varieties needed to grow these crops properly. In Asia, where IRRI claims that its green revolution rice varieties can achieve yields of 10 mt/ha (metric tons per hectare) at the research stations, in practice most farmers only get around 3–6 mt/ha, depending on the country.[21]

Pests and diseases

By planting genetically uniform varieties over large areas under monoculture conditions, the green revolution increased disease and pest population pressures. Once a pathogen or pest has adapted to the defences of one plant, the defence barriers of all the neighbouring genetically uniform plants fall with it. Pests or disease can overrun crops with the same genetic make-up as rapidly as an epidemic:

> In 1973–4 the Philippines rice crop was almost wiped out by tungro, a virus disease carried by the brown plant-hopper – an insect pest which keeps developing new biotypes resistant to the latest crop strain's immunity to it. In 1975 Indonesian farmers lost half a million acres of rice to damage caused by the rice hopper.[22]

Diseases began to break out in places where they had never before been a problem. Genetic diversity is the best protection against pathogens and pests. Monocultures represent a serious loss of biodiversity, thus creating an artificial ecosystem that depends on constant human intervention, mostly in the form of agrochemical inputs. Many scientists agree that monocultures and overuse of agrochemicals have increased outbreaks of disease. Pesticides also kill so-called 'friendly insects' – crucial predators on pests or disease vectors – and fertilisers too can have a very harmful effect on vital soil organisms. The massive use of pesticides helped resistance to develop rapidly among pests. Just using variety mixes can fend off diseases like rice blast.[23]

Increased use of pesticides

Where they had lost the traditional varieties that were often more resistant to pests than the new hybrids, farmers had little choice but to return to their suppliers for new chemical pesticides. The green revolution breeders, for their part, began to search through their collections of landraces or farmers' variety seeds to identify resistance traits/genes that they could crossbreed into their high-yielding varieties. But it may take as little as two years for diseases and pests to overcome the resistance of each new variety that the breeders develop. The result has been perpetual crisis for farmers and a constant race between the breeders and the pests and diseases, which the breeder is guaranteed to lose as the gene pool dwindles, thanks in large part to the loss of on-farm diversity that the green revolution has exacerbated.[24]

The impact of all this fertiliser and pesticide has been extremely serious, causing contamination of the environment and seriously affecting human health. The World Health Organisation (WHO) estimated in 1989 that 3 million people a year suffer acute pesticide poisoning, and that there are many more unreported cases resulting in conditions such as dermatitis. These may result in 20,000 unintentional deaths, a figure that rises to 220,000 when suicides carried out with the aid of pesticide are included.[25] These figures remain the best estimate made so far of the scale of the problem.

Soil and water depletion

Perhaps one of the most serious long-term impacts has been on soil and water resources. Green revolution methods do not maintain the natural fertility of the soil, so farmers need to use more and more fertiliser in order to maintain yields. Treating the soil as a passive medium, where only external inputs are important, means ignoring the complex life of the soil and undermining it for the future (see Box, p. 10: 'Living soil'). The impact of both fertilisers and pesticides on the soil has been little researched, yet food production ultimately depends on soil quality. The green revolution extended Northern industrial practices of depleting the soil rather than maintaining it to vast regions of the South, with the result that soil quality worldwide is seriously compromised. This may be one of the major causes of the decline of green revolution yields and micro-nutrient levels in food.

> Other intensive farming practices, particularly with wheat and rice, have virtually mined nutrients from the soil. When fertilisers are added to a crop, a plant absorbs not only the extra nitrogen, phosphorus and potassium from the fertiliser, but also proportionately increased levels of micro-nutrients from the soil, including zinc, iron and copper. Over time – about 10 years in this case – the soil becomes deficient in these micronutrients. Lack of them also inhibits a plant's capacity to absorb nitrogen, phosphorus and potassium.[26]

The green revolution also required large increases in the use of water, including a huge extension of irrigation facilities. This has reduced reserves of groundwater and lowered water tables in regions such as the Indian states of Punjab and Haryana.

> Irrigation made growing rice possible, and it was introduced as a cash crop and cultivated alongside wheat. Now, however, it has begun to suck the land dry. Excessive pumping during the rice-growing season has led to a drop in the groundwater table of an average of half a meter a year. In some areas, levels have fallen well below the reach of the deep tube wells used by farmers, or the water has become saline.[27]

It has also rendered large areas of land unusable due to water-logging and a build-up of salt in the soil, while water resources have been heavily polluted by fertiliser and pesticide run-off.

Living soil: the importance of a healthy soil food web

A key factor for crop health is a healthy soil food web, as this determines the fertility of soil and its capacity to break down organic and inorganic substances such as herbicides, as well as to drain or to hold water. The soil food web is a complex, interactive and interdependent system of mutually beneficial soil organisms made up of micro-organisms such as bacteria, fungi, algae and protozoa as well as insects, nematodes and earthworms. A teaspoonful (or one gram) of soil can contain 1–600 million micro-organisms from 5–25,000 different species, with conventional agricultural soil often lying in the lower range. In addition, soil is also made up of minerals, nutrients, air pockets, roots and decaying matter.

Scientific research into the soil food web has been underfunded and neglected within agricultural research. Despite this, the knowledge obtained so far shows that soil organisms are vital to plant and soil health, structure and water-retaining properties, to nutrient cycling, and to the accessibility and transport of nutrients to plants. In exchange, plants excrete nutrients such as sugars from their roots as extra food for the micro-organisms.

Mycorrhizae – or root fungi – are particularly important because they link plants with the soil. Through symbiotic relationships they extend the root systems of plants, improving their capacity to take up water and nutrients, and to resist drought, pathogens or toxins. They also modify the structure of the soil in a beneficial manner, reducing the need for fertilisers and pesticides. However, industrial agricultural practices such as fertiliser and pesticide application, irrigation and compaction of the soil all have a detrimental effect on *mycorrhizae*, and most crop plants now lack them as a consequence.

Herbicides and other pesticides alter the balance of soil ecosystems with often detrimental effects on beneficial soil organisms such as earthworms, antagonists to pathogens, fungi (including *mycorrhizae*) and bacteria.[28] Loss of soil organisms leads to nutrient deficiencies and unhealthy plants.

Hidden hunger

The green revolution has been blamed for causing reduced levels of essential micro-nutrients (certain essential vitamins, trace elements and minerals) in food crops. This has occurred for a number of reasons. Green revolution methods and inputs have depleted and degraded soils and killed off many of the micro-organisms that make micronutrients available to plants. Chemical fertilisers are no substitute for organic matter and cannot replace these vital interrelationships or the essential micronutrients in either the soil or the plant. In the search for higher yields, breeders have selected varieties for bulk rather than nutritional value. This has had negative impacts on food quality and human physical and mental health:

> Today, more than 2 billion people consume diets that are less diverse than 30 years ago, leading to deficiencies in micronutrients, especially iron, vitamin A, iodine, zinc and selenium. The green revolution, with its increased global caloric output, is said to have contributed to micronutrient malnutrition afflicting more than 40 per cent of the world population, and it continues to take its toll in developing countries.[29]

Such micronutrient malnutrition can lead to intellectual deficits as well as chronic ill health, affecting the capacity of whole populations:

> Malnutrition has been an accepted cause of intellectual decline since the 1970s. More recent research concerning protein energy malnutrition (PEM), and interrelated social factors, provides better understandings of 'sub-clinical' problems resulting from poor quality food. High-yield 'green revolution' crops were introduced in poorer countries in the 1960s to overcome famine. But these are now blamed for causing intellectual deficits because they do not take up essential micronutrients. They have also displaced other nutritious indigenous food sources.[30]

The FAO has confirmed that micronutrient deficiencies have a serious impact on human health, learning ability and productivity, which has high costs in terms of lost human potential and well-being with serious socioeconomic consequences.[31]

In the UK, the average content of the main minerals in British-grown fruits and vegetables declined by 46 per cent from 1946 to 1991. Comparison of the 1946 and 1991 McCance and Widdowson reports for the UK government on the composition of foods revealed that across all vegetables measured, mineral content in 1946 was 45 per cent higher in magnesium, 46 per cent in calcium, 49 per cent in sodium and 75 per cent in copper.[32] Geologist David Thomas published detailed comparisons between these reports and commented:

> Intensive farming methods during the past 50 years, plus acid rain and overuse of artificial fertilisers, have reduced the absorption of minerals such as selenium and zinc into our fruits, vegetables and grains…. Mass-produced fertilisers generally contain only three minerals, but there are more than 36 known minerals, 21 of which are vital. If they're not in our soil, they're not going to make it into our foods. This imbalance is having a big impact on our health.[33]

- **A closer look at the figures**

In addition to the problems discussed above, it now appears that claims made for the positive impact of the green revolution on the numbers of hungry people require closer examination. Figures suggesting that the number of the world's hungry dropped during the green revolution (942 million to 786 million, a 16 per cent drop in 1970–90) look rather different when China is removed from the equation. China used green revolution methods and is often cited as a triumph, in that crop yields rose by 4.1 per cent a year from 1978 to 1984. What is less often mentioned, however, is that during this same period, China introduced what has been called its third land revolution, the 'household responsibility system', which gave farmers decision-making powers about land use that they had not been allowed under collectivisation.[34] The increases in production correspond with the introduction of household responsibility. Without China, figures show that the number of hungry people in the world actually increased by 11 per cent during the period, from 536 to 597 million.[35]

Thus, in spite of increased amounts of food produced, which have kept pace with population increases, the poor are having more difficulty in accessing food or the means of producing it: land and seed. The green revolution (except possibly in China) did not change existing power structures that led to inequity but actually exacerbated them. It did nothing to improve the distribution of land and resources. Finally, the green revolution is not maintaining its promise. It first showed signs of failure in the very region where it had been most enthusiastically adopted: in Luzon and Laguna, in the Philippines. There, long-term investigations conducted by IRRI show that yields peaked in the 1980s, then levelled off and are now falling steadily. Evidence is now emerging of similar patterns throughout Asia. A major part of the problem is the degradation of the soil through irrigation, impaction of the soil through the use of heavy machinery, and the inputs used, which are likely to have had serious impacts on the soil food web. Since little was known about this web before the damage was done, and little research has been done on damaged soils since then, ignorance of the actual nature of the impacts remains almost complete.

However, even if the gains are not maintained, the green revolution opened up the world's agriculture to agrochemical corporations, as the new seeds were dependent on fertilisers, pesticides and farm machinery. According to Lester Brown of the WorldWatch Institute, corporations had a vested interest in the green revolution:

> Fertiliser is in the package of new inputs which farmers need in order to realise the full potential of new seed. Once it becomes profitable to use modern technology, the demand for all kinds of farm inputs increases rapidly. And so, only agribusiness firms can supply these new inputs sufficiently.[36] This impact may be extremely hard to reverse; these corporations have maintained their grip on agriculture and genetic engineering may simply intensify it.[37]

From war chemicals to agrochemicals

The history of chemical farming inputs, technology initially developed for military use during the twentieth century, illustrates a close relationship between war and the agrochemical industry. As José A. Lutzenberger explains:

> Commercial fertilisers became big business after World War I. Right at the beginning of the war the Allied blockade cut the Germans off from Chilean nitrate, essential for the production of explosives. The Haber-Bosch process for the fixation of nitrogen from the air was known but had not been exploited commercially yet. So the Germans set up enormous production capacities and managed to fight for four years.… When the war was over, there were enormous stocks and production capacities but there was no more market for explosives. Industry then decided to push nitrogen fertilisers onto agriculture.
>
> The Second World War gave a big push to a small, almost insignificant pesticide industry, and really got it started on a big scale. During the Second World War, no poison gases were applied in battle, but a lot of research was conducted. Bayer, among others, were in this game. They developed the phosphoric acid esters. After the war they had large production capacities and stocks and they decided that what kills people should also kill insects. They made new formulations of the stuff and sold it as insecticide.
>
> Shortly before the end of the war in the Pacific, an American freighter was on its way to Manila with a load of potent plant killers of the 2,4-D and 2,4,5-T group. The intention was to starve the Japanese by destroying their crops by spraying the plant poison from the air. It was too late. The boat was ordered back before it arrived. Another group of Americans had dropped the atom bombs…. Same story: large production capacities, enormous stocks with no buyer. The stuff was reformulated as 'herbicide' and unloaded on the farmers.[38]

Thus the processes and chemicals created in the war effort were turned into fertilisers, insecticides and herbicides and formed the basis of the green revolution.

1.3 From green revolution to gene revolution

> *We lost our own seeds when company people and government officers told us that Irri dhan [HYV] was good. Believing them we not only lost our seeds, but we lost our fish because of pesticide, lost our livestock because the fodder was reduced and the quality was bad, and most importantly we lost our health. It took more than 10 years of hard work to reintroduce our varieties and we are far better than before. Now the companies are talking about new types of seed produced by bizarre manipulation [biotechnology] to cheat us again.*
>
> Rekha Begum, Village Kandapara, Delduar, Tangail, Bangladesh[39]

Although it increased production levels for a few key crops, the green revolution did not actually tackle the problem of food insecurity. As Fowler and Mooney conclude:

> The green revolution failed to live up to its promise of solving the problem of world hunger. It failed because the problem was not simply one of too little food and could not be solved simply by producing more. The problem was and is one of maldistribution and ultimately lack of power and opportunity amongst the hungry in Third World countries to participate in the process of food production and consumption.[40]

Groups in the South are also challenging the green revolution's conception of food security and bringing to light the importance of noncultivated crops, which were neglected and jeopardised by green revolution development, to the food security of the rural poor. According to Policy Research for Development Alternatives (UBINIG) of Bangladesh:

> The notion of 'wild' food is misleading because it implies the absence of human influence and management. In reality, there is no clear divide between 'domesticated' and 'wild' species: rather, it is a continuum resulting from co-evolutionary relationship between humans and their environment. Species that have long been considered wild are actually carefully nurtured by people.[41]

Most importantly, the green revolution did not respond to the farmer's needs. It did not explore or support local solutions to food security issues based on local knowledge and related to the specific local conditions. By promising tantalising yields and profits to the handful of farmers able to afford the seeds and inputs on a long-term basis, 'it in fact concentrated rural wealth and power in the hands of a few – exacerbating the very process that had helped create so much hunger in the first place'.[42]

A major weakness of the green revolution was its narrow focus on the seed. It failed to see the farm as a complex system, where the seed is only one element that contributes to overall productivity. As a result, whole areas of research into soil fertility, mixed cropping, water management and other sustainable practices, which can easily double yields, were overlooked as scientists focused on finding the perfect genetic combination, an approach with major limitations. But instead of looking upon the experience of the green revolution as a clear indication that a fundamental change is needed in the way scientists approach agricultural research, proponents of genetic engineering are looking for new ways to expand the search for genes –going beyond the confines of a single species to search for genes across species and even kingdoms. Seen in this way, genetic engineering is merely a means to perpetuate an agricultural model that is long overdue for a profound transformation.

1.4 Economic globalisation and debt creation

The green revolution grew out of a political, social and economic context specific to the post-Second World War period. The end of the Cold War and the growth of corporate globalisation have modified the global landscape and neoliberalism dominates public policy in many countries. Neoliberalism generally involves a belief in unfettered market forces, promoting freedom of movement for capital, goods and services, and the removal of government controls over private enterprise. It breaks links to particular localities and seeks to remove regulation because this distorts markets. It dismantles community networks of care for the weakest members of society, believing they should be replaced by individual responsibility. Often, therefore, it entails budget cuts for health, education and social security programmes and the reduction of workers' rights. Imposed by the global financial institutions throughout the world, and actively embraced by many Northern governments and some Southern ones, its impact has been enormous. The emergence of biotechnology and genetic engineering cannot be divorced from this context of neoliberal globalisation.

- **The oil shock**

In 1973 the Organisation of Petroleum Exporting Countries (OPEC) more than doubled oil prices, gaining some OPEC countries vast sums of money in a very short time and funnelling large amounts of this oil money into banks in the US, Europe and Japan. This

led to lower interest rates and made banks keen to lend money. The increase in oil prices also caused oil-importing, low-income countries to be short of funds. This combination of factors fuelled an orgy of loans. Southern countries took advantage of the low interest rates – offered by private banks, multilateral lending institutions and Northern governments flooded with money from OPEC countries – to borrow heavily. Many used the loans to enrich élite segments of the population. Some – encouraged by the North – invested in transforming their agricultural sectors to take advantage of a buoyant market for tropical cash crops such as bananas, cocoa, coffee and palm oil. Many World Bank client countries became accustomed to supplementing their foreign exchange earnings with loans and using both to consume imported goods rather than investing them in public services. At the same time the increased production and export of natural resources and agricultural cash crops led to falling commodity prices for the indebted countries, necessitating further loans.

- **Commodity price crashes**

When the second OPEC oil price rise occurred in 1979, Northern governments drastically increased interest rates in an effort to curb inflation. The oil price increase tipped the industrialised Northern countries into a deep recession which in turn led to reduced purchase of imports, including products from the South. Southern countries had already found that prices for their raw materials – such as copper, coffee, tea, cotton and cocoa – were falling, and now demand was sharply cut. With higher interest rates and reduced income, the long-term external debt of Southern countries soared: massive defaults looked imminent, threatening the global financial system.

- **Enter structural adjustment**

At this point the World Bank and International Monetary Fund (IMF) began to impose stringent conditions for further loans, known as structural adjustment programmes (SAPs). The programmes aimed to facilitate debt repayment by increasing export earnings and foreign investment through the restructuring of national economies and social systems. They also opened up national industries and natural resources to foreign corporations. This brought heavy social and environmental costs as countries were forced to cut their education and health programmes, reduce workforces, and deregulate environmental controls. Yet most countries still did not succeed in actually repaying their debts and many ended up on a treadmill of further borrowing in order to service existing debts. Many countries have now paid the original amount borrowed many times over in debt service charges, but have never managed to pay off the principal and regain their independence. Some would say that this has been a deliberate policy of control on the part of the wealthiest nations. International indebtedness of low-income countries increased from $134 billion in 1980 to $473 billion in 1992, while their excess of imports over exports increased from $6.4 billion to $34.7 billion.[43] The financial institutions have used their stranglehold over Southern governments to dictate terms favourable for the entry of the transnationals. Even debt forgiveness, campaigned for over many years, is being made conditional on countries putting World Bank- and IMF-approved economic reforms in place, through the Heavily Indebted Poor Countries (HIPC) Initiative.[44]

- **Adjusting the food trade?**

As has been pointed out by many researchers, food production and consumption were local until market economies emerged, which in turn drove the growth of global food trade. In order to pay back their debt, countries are still being encouraged to switch from agricultural production for their own local and national needs to the export of cash crops. This is leading to local and national food insecurity, with countries being urged to continue to export food, even when threatened by national shortages (Ireland and Ethiopia during famines, and Malawi in 2002–3). Holding of food stocks is discouraged by the international finance institutions, who advocate selling them off to repay debts. For a country to seek self-reliance or self-sufficiency in food is now derided as out of date in a world of international trade. This further increases dependence amongst countries.

1.5 Free trade and its inconsistencies

SAPs are part of a wider philosophy of free trade that has been gaining momentum since the 1980s. This philosophy is promoted by transnational corporations (TNCs) in the World Trade Organisation (WTO) and supported by many Northern governments. It not only proposes that national economies should be opened up to foreign competition and investment, but also that state intervention in the economy should be discouraged, especially measures designed to protect the country's own production and resources. Meanwhile the US and the EU continue to subsidise their agricultural sectors both directly and indirectly, which makes it impossible for farmers in Southern countries to compete in domestic or global markets. However, this does not mean that Northern farmers are prospering. In fact, small farmers – and, increasingly, medium-sized farmers – are being forced to quit by low farm-gate prices and heavy debts. Hundreds of thousands of farmers have left the land in Europe

(200,000 farmers and 60,000 beef producers in 1999) and the US (235,000 farms failed during the mid-1980s farm crisis).[45] The beneficiaries are the largest farmers, national and international supermarket chains, and the food and agribusiness TNCs.

State intervention in the form of national regulation and international treaties protecting human rights, animal rights and the environment, are also being challenged through the WTO, as free trade philosophy considers them barriers to trade. Proponents of free trade theory believe that corporations will regulate themselves and do not need state or multilateral regulation.

Furthermore, free trade is supposed to encourage competition between corporations leading to greater efficiency and higher productivity, but in fact TNCs around the world operate virtual monopolies. Two-thirds of international trade is handled by global corporations and a third of all trade is intra-TNC transactions.[46] TNCs also control around 80 per cent of all foreign investment.[47] Fewer than five companies control 90 per cent of the export market for each of wheat, corn, coffee, tea, pineapple, cotton, tobacco, jute, and forest products.[48] This kind of consolidation is especially evident in genetic engineering, where, even by 2000, just five companies controlled nearly 100 per cent of GM seeds:

> The American Corn Growers Association noticed that the five 'gene giants', Syngenta, AstraZeneca, Aventis, DuPont [owns Pioneer Hi-Bred] and Monsanto [owns DeKalb], control virtually 100 per cent of the genetically modified seed business. The top 10 consolidated seed companies now control 33 per cent of the $23 billion world seed trade and the top ten agrochemical companies control 91 per cent of the $31 billion agrochemical market. Vertical integration means these companies have some form of control over all aspects of a commodity, through holding patents on the technology, owning the seed production and sales process, enforcing provisions in farmer contracts and manufacturing and distribution of the processed foods marketed to the consumer.[49]

In 2002 consolidation continued, when DuPont and Monsanto agreed to share their proprietary agricultural biotechnologies with each other.[50]

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