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**THE ETHICS OF GERMPLASM TRANSFER: THE BEHAVIOR OF MULTINATIONAL
CORPORATIONS IN SCIENTIFICALLY WEAK COUNTRIES**

by

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Capitalism is the prevalent economic paradigm in most of the germplasm-rich regions of the world, including Latin America. Most of the nations rich in germplasm have democratically elected governments and to a degree, their economic, social and cultural policies are carried out with a significant popular backing.

Free enterprise, the accumulation of capital in the private sector of the economy, the private ownership of the means of production, the exchange of labor power for money, the search of competitiveness to secure markets through a multiple strategy involving science, technology, politics, diplomacy, and war, as well as the first and ultimate objective of capitalism, the maximization of profit, are (a) accepted and (b) not challenged on moral grounds.

THE CONCEPT OF GERMPLASM ROBBERY IS A NEW ETHICAL ISSUE

While germplasm transfer among nations is as old as human history [1][2][3], the ethical analysis of its legitimacy is rather new. Egyptians pharaohs led powerful expeditionary armies to conquest valuable germplasm in foreign lands, and the history of the colonial expansion of Europe can be viewed as a massive program for the appropriation and relocation of germplasm from Africa, Asia and the New World. Yet the ethics of germplasm acquisition has emerged as a matter of concern only during the last twenty years, with the questioning the free appropriation of Third World genetic resources by the TNC/PACS of the First World [4][5][6][7].

However, the revolutionary changes that have occurred both in the world political scenario and in the biological sciences have

markedly modified the global panorama.

The dismissal of most of the "socialist" regimes of Eastern European countries and their return to market economies has created new paradigms of international behavior and international relations.

Molecular biology has become an intellectual tool of extraordinary economic and technological value. Industrial molecular biology --i.e. the biotech industry-- is a global endeavor and has no boundaries for the acquisition and exploitation of ideas, technology and information [8][9][10][11].

The globalization of the world economy is the new reality, with the consequent tendency towards the elimination of trade, ownership and financial barriers. The attenuation of national boundaries limiting the appropriation of enterprises, natural resources, commodities, and ideas, has induced the progressive collapse of isolationist, protectionist and nationalistic trade policies [12].

It is within this new political, economical and scientific context that the ethics of the appropriation by the powerful transnational corporations of the pharmaceutical/agrochemical/seed industry (TNC/PACS) of valuable plant, animal and microbial germplasm present in the Third World must be analyzed.¹

WHY THE THIRD WORLD STILL MATTERS TO THE TNC/PACS

For the time being, the Third World is important for TNC/PACS for three main reasons:

1. TNC/PACS need the potentially useful genes present in the

centers of diversity of the Third World.

2. TNC/PACS need testing facilities for (i) exploring the agronomic behavior of new, genetically engineered varieties, and (ii) for trying new agronomic procedures, taking advantage of the soft regulatory environments prevailing in the Third World.²

3. Third World countries are important markets for their seeds, agrochemical inputs, and human, veterinary and plant health products.

Yet things are likely to change in the future, specially with regard to reason (1). Until now, it was virtually impossible to create varieties compatible with the modern trends of agriculture without incorporating genes present in the vast genetic reservoirs of the Third World. This technological paradigm --the "blind" search of new genes from an explored genetic pool-- will change as a function of the discovery of the genes and gene products controlling those agronomical traits of agroindustrial significance [11][13].

While it is impossible to predict with precision when this change will occur, the scientific and technological campaigns needed for achieving this objective --the First World genome projects-- have already begun in earnest. The genome projects for the physical and genetic mapping of the chromosomes of the human species and other relevant animals and plants are deliberate programs of technological development and data acquisition. They will result in the identification of key genes and the custom modification of specific characteristics of animals and plants to

suit the requirements of agroindustry and generate new generations of drugs and new drug-delivery systems (genes) [14].

The success of the First World genome projects will mean for the TNC/PACS the possibility of by-passing the centers of genetic diversity as the purveyors of useful genes, as well as the acquisition of key genes without the need of the cumbersome, expensive and (currently) political sensitive operations of gene gathering, storage and transfer.³

THE ETHICAL CODE OF THE TNC/PACS

The TNC/PACS corporate behavior is based on the manipulation of comparative financial, commercial, political, scientific, legal, and natural factors to increase their revenues [15][16][17]. The unique objective of these corporations is the maximization of profit.⁴

Profit seeking is currently an increasingly accepted and respected aim in a world that, by and large, is accepting and complying with the social paradigm of asymmetry in class and power compatible with the reproduction and the supremacy of capital, and idealizing competitiveness and the marketplace as the main factors regulating the economy [18].

As long as TNC/PACS achieve these objectives without toppling governments, killing political adversaries, bribing administrators, and violating safety and environmental rules, while respecting the accepted rules of the game (paying taxes, abiding to national and international laws of ownership, commerce and trade, following standard safety regulations of procedures, and keeping to the truth

in their advertising campaigns), it is hard to claim ethical wrongdoing on their part.

To the extent that their political, fiscal and public behavior is lawful, and when they do not violate national and international codes of action, TNC/PACS per se cannot be blamed for exploiting all the resources available to them in a given operating theatre.

WHO SHOULD CONTROL THE TNC/PACS

Democracy implies a continuous interplay of checks and counterchecks, based on the accountability of the actions of private and public officials, individuals and institutions. The failure to exercise the civil rights of criticism, public evaluation, and opposition to events, behaviors and policies considered deleterious to the societal body as a whole, constitutes a serious instance of political irresponsibility.

The responsibility of controlling TNC/PACS actions, and limiting any possible untoward consequences of their operations, lies with the politicians, administrators, academics, union leaders, businesspeople, bankers, journalists, and grassroot organizers of the Third World.

Those are the social actors that should be able to understand, analyze, explain, denounce, organize, and mobilize society to block any harmful practices of TNC/PACS. Their actions should create the objective and subjective conditions leading to the reform of national laws and the establishment of new codes of procedures to preserve their countries from unsafe, unwise, deleterious, or simply gratuitous exploitation.

If Third World countries ruled by democratically elected governments fail to exert this control, the blame must be placed squarely on those who are involved in the political and administrative processes, and who either refuse to act in defense of their countries' interests and/or conspire with TNC/PACS.⁵

The acquisition of Third World germplasm by TNC/PACS cannot be automatically labeled as unethical. TNC/PACS merely take advantage of the political, economic, regulatory, and cultural weakness of the Third World, and exploit them.

Like the perfect gases, TNC/PACS tend to occupy the whole space left available to them. They cannot be blamed for the fact that the social containment of their diffusion in the Third World is faulty and compliant, unless the historic dimension is included in the analysis.

THE REALITIES OF GERmplasm TRANSFER

It is impossible to block the appropriation of germplasm through restrictive laws and custom regulations, since contemporary biology makes it possible the smuggling samples of biological organisms and their parts. A handful of seeds, a minute sample of a plant or animal tissue (in theory, a single cell would suffice), a few micrograms of DNA, or a written nucleotide sequence, is all what is needed to steal useful biologic material.

Yet Third World countries, that tend to excel in the art of self-deception, ignore these realities and insist on "protective" legislation which cannot be enacted. These pseudoregulations are useless but give the illusion of political strenght.

On the other hand, Third World countries lack of national policies stimulating the commercial exploitation of their biological resources with industrial potential. Their scientific weakness is illustrated by the lack of the scientific capabilities needed for identifying, modifying, manipulating, patenting, and finding original and commercially attractive uses for the genes present in their centers of diversity [19][20][21].

The structural characteristics of the Third World chemical and pharmaceutical companies reinforce and underline this scientific weakness. The capitalist rationality of these industries has been based on the simple copy or fractionation of products invented and developed in the First World, taking advantage of protectionist policies of industrial development that did not consider the strategic need to create world-competitive innovations.

These enterprises were never involved with, and accordingly lack experience in the generation of original research. They neither invested nor induced their governments to invest in the formation of the human capital and the sort of scientific establishments needed for being world-competitive on the basis of new, highly differentiated products of universal use and appeal.⁶

THE ROLE OF TNC/PACS IN SHAPING THE THIRD WORLD

Although retroactive ethical considerations are pointless, it is politically necessary to understand the role that TNC/PACS played in shaping the scientific and technological reality of the Third World.

The financial, political and cultural framework prevailing in

most of the Third World accurately reflects the effects of decades of political abuse, social destruction and cultural degradation. There is incontrovertible evidence that some TNC --but by no means all TNC-- were directly involved in the raise of dictators and supported (like their national counterparts) authoritarian regimes in the Third World, taking advantage of the tight discipline imposed to labor and the silencing of civil and intellectual rights.

These dictatorships never failed to degrade, persecute, and weaken the universities and the research establishments, and were and are the most successful and powerful inducers of expatriation and exile of Third World scientists.⁷

Yet retroactive ethical considerations are pointless, because of their political uselessness.

The inprint left on the educational, scientific and cultural framework of the Third World by its authoritarian regimes is widely felt. Apparent discrepancies (or irregularities) observed in the extent of its destruction are meaningless when compared with their weakness vis a vis the industrialized world, and the magnitude of the forced expatriation of talent (another form of germplasm robbery) which they induced.⁸

THE FALSE BELIEFS AND WRONG EXPECTATIONS OF THE THIRD WORLD

One of the consequences of the scientific weakness and the technological irrelevance of the Third World is the confusion concerning the nature and the goals of the university and the objectives of biotechnology. The political liabilities stemming

from these misunderstandings are multiple and severe.

A clamor resounds throughout the Third World asking for the transformation of the universities in "useful" institutions, devoted to solve the technological problems experienced by the productive sectors. Moreover, universities are asked to be financially self-reliant, an objective to be achieved by performing as hired hands for the agricultural producers and the industry. Thus, the selling of services has become the main task of Third World university administrators, and the obsession of the faculties.

The role of the university, however, is not that of a substitute of absent corporate laboratories, and spend its intellectual energies and physical resources performing trivial developments and/or quality control. Moreover, the strategic objective the university is not be commercially sound, but to be socially sound.

An university is socially sound when it generates a steady stream of bright ideas and discoveries, and shapes numerous and bright intellectuals that can discover and invent. Universities should be the place where the useful theoretical and physical instruments as well as the professionals needed for transforming our world are created and educated.

The misinterpretation of the role of the university and its relation with industry, played and plays a central role in the disinformation campaign waged by the First World to degrade the scientific preparedness and autonomy of the Third World, and dim

the scope and strategic objectives of biotechnology.

TNC/PACS are the producers of the technological inputs of the so-called "Green Revolution," and they lawfully profited by the modernization of agriculture and the expansion of the frontiers of rural capitalism in many Third World countries.

Yet they also advertised as self-evident truths two hypothesis that were either false or at least unproven, namely that the "Green Revolution" was to solve the hunger problem in the Third World, and that low grade technological research was all that was needed in the Third World to sustain its agricultural development [22].

TNC/PACS collaborated closely with the international development organizations and banks, for the establishment of policies of "scientific" development in the agricultural sector of the Third World which strongly contributed to the stagnation of their agricultural research. They created institutes for crop improvement which, far from preparing the Third World for understanding the importance of molecular biology and its potential impact on agriculture, were and are training grounds for technicians involved in routine techniques (which of course, nowadays have a "molecular" tinge, but still are routine).

This international centers were efficient machines for free germplasm export to the First Word, as well as the communication and control centers of the educational and adivertising campaigns dedicated to spread the self-defeating gospel of "appropriate" technologies [23].

These "appropriate" technologies --the routine crossing and

field testing of varieties, the field experimentation with fertilizers, herbicides, insecticides, fungicides, the cataloguing of "local" diseases, and the collection, classification and storage of germplasm-- are conceptually rudimentary activities with a low scientific content.

Purportedly oriented to "solve" local problems, these agronomical institutions were in fact involved in the selection, storage and export of germplasm --as well as the field trial of agronomical procedures--needed by the TNC/PACS. They were the training ground of thousands of agricultural technicians and agrarian economists that populate and direct the scientifically weak agricultural "research" establishments of the Third World.

DOUBLE STANDARDS ARE AN ETHICAL FAULT

The type of agronomical research practiced in these international centers for crop improvement has few elements in common with that practiced in the TNC/PACS corporate labs, in the biotech companies with which they collaborate, and in the academic labs of the First World with which they are technically associated.⁹

TNC/PACS have obvious double standards. What they consider "good research" in the Third World is qualitatively different from the scientific and technological performance they ask for and obtain in their research --intramural and extramural-- ventures in First World countries. This is a well known TNC industrial strategy, but in the case of agriculture is compounded by the fact that TNC/PACS succeeded in convincing the Third World that this was

the right thing to do.

The appropriation of germplasm derived from the Third World's centers of diversity by TNC/PACS cannot be considered per se unethical whenever it does not violate explicit laws forbidding its collection and export. Yet TNC/PACS behavior is unethical to the extent that they foster a system of double standards in science and technology which helps in perpetuating and enlarging the gap between the technological capabilities of the First and the Third World.

These policies help to instill the highly corrosive and destructive Third World ideology of the "science of the poor" and "science for the poor," which has been a very successful engine for underdevelopment.¹⁰

This gospel reinforced the anachronic, reactionary, and obsolete academic structures of the Third World. By suppressing molecular genetics and molecular cell biology from the scenario of agricultural development, they exposed agronomists, farmers, administrators, and politicians to an intellectually debased activity that has few things in common with science and but a distant connection with genetics.

The same is happening now with micropropagation. During the height of the Green Revolution, the mindless crossing of varieties was glorified as being "applied genetics." Nowadays, the trivial micropropagation of species is called "biotechnology." Real agronomic research is often substituted by training in the crudest types of genetic crossing, storage, manipulation, and propagation.

"Modernization" means the piecemeal application of some molecular techniques (e.g. RFLP) for the tentative physical mapping of some agronomic traits, to pave the road to the actual isolation of the stratetic genes in the laboratories of the First World.

These "modern" and "molecular" research programs are not likely to lead to epoch-making discoveries in the biological and chemical sciences, and accordingly they fail to create real biotechnological opportunities.

Yet they are very useful for the TNC/PACS, because they provide the raw genetic material, and the screening and field testing opportunities needed by their scientists to prepare and refine their transgenic and metabolically-engineered species, design drugs and agrochemicals, and evaluate their agronomic and economic performances.

There are not two sciences, one fit for the poor and ignorant, and other belonging to the rich and cultured.

But again, it would be absurd to blame only the TNC/PACS for the massive acceptance of these agenda by whole continents. Corporations are not totipotent social creatures, and their political and ideological success indicates that the politicians, scientists, administrators, industrialists, and farmers of the periphery have been and are rather willing to hear their arguments and their propositions with eager interest.¹¹

A CASE OF UNETHICAL ADVERTISING

Ultimately, both the "Green Revolution" and "biotechnology" were massive advertising campaigns targeted to win the hearts and

minds of the Third World. The perspective of solving serious social and political problems by means of quick technological fixes, and the illusion of attaining food security and increasing exports through the application of routine technologies were very attractive to poor, debt-ridden countries haunted by the spectres of deteriorating terms of trade.

Only that the "Green Revolution" did not feed the hungry masses of the Third World, and that cash crops are a losing game, with many of them targeted to be replaced by biotech products, or readied for production in the North, and always selling cheaper.

The last propaganda blitz hitting the Third World is a disinformation campaign on the Human Genome Project, which is pictured as a humanitarian attempt to "know what we are" for the "benefit of mankind" [24]. This bland rhetoric has the purpose of catalyzing the free flow of interesting human genes (ideally, in the form of sequenced DNA or, as happens today, as crude DNA) to the North, and carefully conceals what the Human Genome Project is: a strategic program, a deliberate initiative for technology development aimed to secure key methodologies and data for the pharmaceutical, agrochemical, chemical and seed industries of the First World.¹² The Green Revolution, pseudobiotechnology¹³ and now, the Human Genome, were preceded and accompanied by an advertisement campaign designed to transfer a package of scientific beliefs and technological targets to the Third World.

Are these corporate policies liable to be considered ethical crimes? In fact, we are concerned with a dilemma which carries us

to the discussion of the ethical limits of advertising.

The deliberate practice of misinformation is an ethical fault, an unethical commercial practice.¹⁴

If these advertising/educational policies are considered to be deliberate, conscious and systematic actions to preserve the Third World in a state of docile ignorance, then TNC/PACS have incurred in unethical commercial practices.

Instead of securing markets by achieving and selling superior, highly differentiated products, they distorted reality by thwarting the emergence of potential competitors. They did so by reducing their awareness about both the nature and the extent of the genetic revolution in agriculture, and by blocking their awareness concerning the real dimensions of the potential richness hidden in their genetic resources.

These advertising campaigns succeeded in creating several generations of agronomists and agrarian economists who are strong believers in the altruistic slogans of the "Green Revolution," pseudobiotechnology, and the Human Genome project. The Third World was deprived of the experts that should have understood, detected and appraised the new scientific developments in the molecular sciences and their potential multiple impacts on agriculture and agroindustry.

The same "experts" that sold the Green Revolution now preach the marvels of pseudobiotechnology. It is not surprising, then, that no real alerts were given to the Third World, which was unable to design policies to counteract the potential impact of this

scientific revolution on their countries' economies.

As a consequence of this void, many in the Third World still keep on speaking and writing about "transfer of technology," a meaningless and unexisting concept in biotech.¹⁵

This deliberate obliteration of cultural capability is unethical, because it is orientated to perpetuate the conditions of unequal exchange.

Thus, the first impact of the revolution in the molecular sciences on agriculture, the conversion of commodities in proprietary products and the potential repercussions of industrial molecular biology on the substitution of cash crops, passed largely unnoticed for almost 15 years.

BACK TO THE ROMAN EMPIRE (29 B.C. TO 395 AD)

The nations of the industrialized world are furiously competing among themselves to develop the coherent scientific research policies (both in the public and the corporate sectors) needed for the creation of new commercial opportunities and tight technological packages in the pharmaceutical, chemical and food industries.

While TNC/PACS continue to forge ahead their scientific and technological lead to compete in the international marketplace, Third World countries are brain-washed into pseudobiotechnology. A new wave of technocratic optimism and mild scientism keeps insisting on the fairy tales of the past.

The "Green Revolution" and pseudobiotechnology have induced and consolidated the total divorce between science and practice in the

Third World, which has retrograded its cultural development to the era of the Roman Empire.¹⁶ The grandiose schemes designed to bring about technological development without a concomitant scientific development failed, and the result was keeping the Third World in the shadow cone of progress.¹⁷

The scant --human and financial-- resources of the Third World scientific establishments are deviated to dead ends, while research on key strategic subjects is restricted to the industrialized countries.

THE CONCEPTUAL POVERTY OF CURRENT CRITIQUES

These facts are generally not taken into consideration by the critics of the TNC/PACS.¹⁸ Much stress is placed in the "robbery" of germplasm, on the "fraudulent" nature of the exchange.

Yet who defines the "just" price of germplasm?

There is no doubt that the \$6 million paid by USAID to Latin American institutions involved in germplasm "research" [5] is a ridiculous figure ridiculous compared with the billions of dollars that the seed markets are worth. Yet again, is not bargaining one of the characteristic "rights" of the capitalist book of ethical rules?

Bargaining is precisely what is lacking in the Third World. And this absence of bargaining strength is not due exclusively to the political and financial context: the scientific weakness of the Third World is an essential component leading to its utter inability to negotiate with the First World.¹⁹

Finally, it must be remembered that TNC/PACS were not passive

observers of the creation of the foreign debt and the immense capital flight from Latin America --that amounted to \$151 billion in the years 1973-1985 [25]-- which so much condition the political possibilities of the Third World.

Any comprehensive analysis of the ethical behavior of TNC/PACS must necessarily include the consideration of these facts.

WHAT TNC/PACS SHOULD DO IN SCIENTIFICALLY-WEAK COUNTRIES

The reasons why the First World should be specially interested in the economic growth and well being of the Third World have nothing to do with social justice or the drive of compassionate industrial leaders with good feelings.

A prosperous Third World would mean the opening of huge markets for the high-value products of the Third World, and the reduction of the risk of launching expeditionary wars which are always onerous in money and limb, and with long range --and politically unforeseeable-- repercussions.

The paternalistic attitude which so often impregnates the dealings of many First World organizations with the Third World is especially repugnant because it implicitly assumes the intellectual inferiority of the peoples of the Third World.

This assumption is completely unwarranted, since the Third World has been a steady provider of first rate intellectuals to the First World, who have played a substantial role in shaping the economic success of the industrialized countries.

In fact, the worn out letany of the brain drain gives a very static picture of the reality of the expatriation of intellectuals.

Every first rate Third World scientist that is sent to exile by political, economical, religious, racial, or economic causes is not merely one person less in the cultural structure of her/his country, but a person added to the army of discoverers and educators of the First World.

The real measure of the brain drain is not given by the number of expatriate scientists, but by the number and quality of their contributions to science and technology, as well as by the number and quality of their graduate students and postdoctoral fellows.²⁰

In other words, TNC/PACS have much to gain by tapping the talent present in the Third World.

On the other hand, the behavior of corporations and entrepreneurs do not necessarily follow the "constructive and innovative script" that advertising attributes to them. There are times that the corporation and the entrepreneur may pursue a type of parasitical activity that damages the economy [18]. TNC/PACS have a single objective: maximize profit. The "reward structure of the economy" (the rules of the game) will dictate the way in which these corporations will allocate their resources and orient their investments [18].

The challenge, therefore, is to find a coherent and effective way for reorienting some of the scientific policies directly and indirectly induced by TNC/PACS in the Third World, and begin the construction of its scientific capability.

First of all, TNC/PACS should correct their unethical commercial behavior when dealing with the Third World. The mere

adherence to this basic commercial precept would lead them to a very straightforward agenda for the scientific development of the Third World.

1- TNC/PACS should apply a single standard in their dealings with the world scientific community, and behave in the Third World as they do in the First World.

In the U.S., most TNC/PACS are strong supporters of university fundamental research, and often shelter, back and protect university scientists from the pressures applied by university administrators and non-research faculties. This is specially true in institutions that do not have a strong tradition in research, and where active scientists are still a minority. In fact, the new industrial parks in the U.S. Southeast have strongly contributed to the marked changes perceived in the universities with which they are related.²¹

On the other hand, TNC/PACS seldom interact with the universities in the Third World, and when they do, their effect is often deleterious. They tend to use the universities purveyors of local technical personnel and in situ routine development work.²² By doing so, they protect and enhance the most conservative and usually reactionary members of the faculty. Their "backing" of fundamental science has advertising undertones, and is usually limited to offering a certain number of fellowships, and establishing prestigious prizes which are shared by the scientists of the establishment.²³

2- TNC/PACS operating in the Third World should invest a fraction

of their earnings in improving the fundamental sciences in their
hos countries.

These investments should back a coherent policy aimed to
compensate and complement the obvious and serious weakness of Third
World Science. Such a coherent policy should include:

- * Equipping and staffing university research laboratories with the
best local people and visiting staffs.

- * Offering fellowships, subsidies and grants for the graduate
training of the best students in the most advances research
universities in the First World.

- * Bringing visiting professors from the leading research
universities of the First World to teach the strategic
undergraduate and graduate courses in the fundamental sciences, and
to do research in the local universities with local teams of
professors and students. Inspired teaching by those who shape the
leading edge of science would contribute to shape the mentality of
students and establish the standards with which the university
should select and evaluate its faculty. Natural connections would
be established between the academic communities of the First and
the Third World, and the unidirectional flow of talent to the North
could be halted and transformed in a two-directional avenue of
interchange.

- * Stimulate and facilitate the radication of First World senior
distinguished professors in retirement age who are still actively
and successfully pursuing scientific research, in the Third World.
Corporations should provide them with housing and laboratory space,

and the senior professors would bring their retirement salaries and not be in the local university payroll. This would increase the quality of Third World Universities and contribute to the education of students and scientists in the Third World, without interfering with the incorporation of new young faculty members.²⁴

* TNC/PACS and Third World governments should establish regional research centers concentrated in the scientific study of indigenous plants, animals and microorganisms with potential or actual commercial interest. Data of immediate or potential value should be patented jointly by the TNC/PACS and these regional institutions, and the scientists involved in the patented discoveries and developments should receive a percent of the royalties generated by the patents.

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REFERENCES

- [1] Brockway, L. H. 1979. *Science and Colonial Expansion: The Role of the British Royal Botanical Gardens*. New York: Academic Press.
- [2] Brockway, L. H. 1988. *Plant Science and Colonial Expansion: The Botanical Chess Game*. In *Seeds and Sovereignty* (Jack R. Kloppenburg, Jr, Editor) Durham: Duke University Press.
- [3] Crosby, A.W. 1986. *Ecological Imperialism: The Biological Expansion of Europe 900-1900*. London: Cambridge University Press.
- [4] Kloppenburg, Jr. J.R. 1988. *First the Seed: The Political Economy of Plant Biotechnology*. New York: Cambridge University Press.
- [5] Fowler, C. and Mooney, P. 1990. *Shattering: Food, Politics and the Loss of Genetic Diversity*. Tucson: The University of Arizona Press.
- [6] Mooney, P. 1983. *The Law of the Seed: Another Development and Plant Genetic Resources*. Developmental Dialogue #1-2.
- [7] Fowler, C. Lachkovics, E., P. Mooney and H. Shand. 1988. *The Laws of Life: Another Development and the New Biotechnologies*. Developmental Dialogue #1-2.
- [8] Kenney, M. 1986. *Biotechnology: The University-Industry Complex*. New Haven: Yale University Press.
- [9] Goldstein, D.J. 1988. *Biotechnology, Universidad y Politica*. Mexico D.F.: Siglo XXI Editores.

- [10] Busch, L., Lacy, W.B., Burkhardt, J., and Lucy, L. 1991. **Plants, Power and profit: Social, Economical and Ethical Consequences of the New Biotechnologies**. Cambridge, MA: Basil Blackwell.
- [11] Goldstein, D.J. 1991. **Pseudobiotechnology: A Pathway to Underdevelopment, Misery, and more Trade Deficit. Biopolicy** (in the press).
- [12] Frank, A.G. 1991. **Another look at history (in transition). IFDA Dossier 80: 77-84.**
- [13] Goldstein, D.J. 1990. **The Commercialization of Biotechnology for Food Production. Workshop on Biotechnology for Food production in Dry Areas (UNCST/ABN).**
- [14] Goldstein, D.J. 1991. **Third World Biotechnology, Latin American Development and the Foreign Debt Problem. Submitted for publication.**
- [15] Hobsbawm, E. 1969. **Industry and Empire from 1750 to the Present Day**. Harmondsworth: Penguin.
- [16] Chandler, Jr. A.D. 1962. **Strategy and Structure: Chapters in the History of the American Industrial Enterprise**. Cambridge, MA: M.I.T. Press.
- [17] Nelson, R.R. and Winter, S.G. 1982. **An Evolutionary Theory of Economic Change**. Cambridge, MA: Belknap, Harvard University Press.
- [18] Baumol, W.J. 1990. **Entrepreneurship: Productive, Unproductive, and Destructive. Journal of Political Economy 98: 893-921.**

- [19] Goldstein, D.J. 1989. Ethical and Political Problems in Third World Biotechnology. Journal of Agricultural Ethics 2:5-36.
- [20] Goldstein, D.J. 1989. A Biotechnological Agenda for the Third World. Journal of Agricultural Ethics 2:37-51.
- [21] Goldstein, D.J. 1987. Molecular Biology and National Security. In Seeds and Sovereignty (J.R. Kloppenburg, Jr. J.R., Editor), Durham: Duke University Press.
- [22] Levins, R. 1974. Genetics and Hunger. Genetics 78: 67-73.
- [23] Goldstein, D.J. (1991) Implications of biotechnology in the Third World. Journal of Scientific and Industrial Research. In the press.
- [24] Allende, J.E. 1991. A View from the South. Federation of American Societies of Experimental Biology Journal 5:6-7 (1991).
- [25] Pastor, M. 1990. Capital Flight from Latin America. World Development 18:1-18.
- [26] Hirschman, A.O. 1990. The Case Against "One Thing at a Time." World Development 18:1119-1122.
- [27] Doeringer, P.B. & Streeten, P.P. 1990. How Economic Institutions Affect Economic Performance in Industrialized Countries: Lessons for Development. World Development 18:1249-1253.

NOTES

1. A more adequate description of these companies would be "national corporations with multinational involvements," since independently of their tax shelter homes, they certainly consider with great attention their national interests. In the context of this paper, however, their nationality is irrelevant: they all belong to the First World.
2. Calgene (Davis, California), one of the leading agrobiotech companies, is field-testing some of its genetically-engineered tomato strains in Mexico and in South Africa. The first (illegal) environmental release of a recombinant vaccinia-rabies construct was made in Argentina (see Goldstein, 1989a).
3. The *Arabidopsis thaliana* genome project will lead to the discovery of the genes and the genetic regulatory circuits which determine the molecular bases of fundamental physiological, pathological and adaptative mechanisms in plants. These genes are very likely to be highly homologous to those carried by plant species of current or potential commercial interest, and their isolation genes will require only the right oligonucleotide probes, a PCR machine, and a few micrograms of DNA.
4. "It is often assumed that an economy of private enterprise has an automatic bias towards innovation, but this is not so. It has a bias only towards profit." [15]

5. There are at least four categories of actors that can be identified:

(a) Business partners of the TNC/PACS, ideologically and financially committed to the success of their joint commercial ventures, who exert political influence to maintain the statu quo.

(b) Lawyers and politicians who care, yet are unwilling to understand the scientific content inherent in the capture and the protection of germplasm.

(c) Politicians who do not care about the problem.

(d) Active and conscious agents of the TNC/PACS, who deliberately hinder the regulatory process.

6. The fact that the pharmaceutical and chemical industries in Third World countries never complain about the quality of their (public and private) national universities is very significant. The decline or the lack of improvement of the academic standards and the scientific output of Third World universities is not a source of concern for this industrial sector, which can maximize the generation of profit without any concern on innovation. This indifference contrasts with the preoccupation with which the U.S. chemical and pharmaceutical industries witness the current crisis in American scientific education, characterized by reduced mathematics and science skills of secondary school graduates, the lack of adequate funding for good research proposals, the departure of young university investigators to better payed and more secure jobs, the "graying" of faculties, the shrinking number of college students, and the alarming fall in the number of U.S. graduate

students in the strategic disciplines. (Cf. Pharmaceutical Manufacturers Association Foundation, The Washington Post A20, February 14, 1991).

7. A. Hirschman recently wrote that "there can be considerable economic growth and progress and perhaps also an improvement in the distribution of income without any concomitant advance in political openness or decline in repression, just as the inverse development can go on for a considerable period of time: a strengthening of democracy can go hand in hand with a weakening of the economy." [26].

8. Iraq, Brazil and Chile are three countries that "succeeded" in developing conventional weapons industries under harsh military dictatorships.

This kind of development resulted in increased military capability for conventional warfare (the case of Iraq) and substantial exports of conventional military equipment (the cases of Brazil and Chile).

The sequestration of money and talent in non-productive technologies did not result in the autonomous development of these nations. The transference of conventional aeronautical, biochemical, microbiological, ballistic, and communication technology to Iraq did not modify its chances against the scientific and technological might displayed by the US army. In fact, while in theory the massive Iraqi build-up could have resisted the actions of the expeditionary forces, its scientific

and technological resources could not compete against the constant upgrading of the American technology. The strategic unbalance was induced by scientific and technological means rather than by the sheer size of the U.S. army and its fire-power.

The simultaneous absence of a clear political objective and a will to fight based on a consensual appreciation of the correctness of that objective (the Vietnamese weapon), as well as the lack of scientific capability needed to challenge the high-tech war environment created by the U.S., resulted in the collapse of the Iraqi adventure.

The future markets for the conventional weaponry exported by Chile and Brazil have been also put at risk by the Persian Gulf war. Their effectivity has been shown to be nihil when confronted with the technological prowess of the First World, which have proven them obsolete. Their upgrading would need a substantial incorporation of original scientific results in mathematics, physics and computer sciences, disciplines which barely exist --if at all-- in most of the Third World.

The technological dynamism shown by the American expeditionary force during the Gulph War is directly derived from the scientific dynamism of the US war industry, which is deeply connected, integrated and sensitive to the relentless progress in mathematics, physics, computer sciences, and the molecular and material sciences. The advancement of science on which the military and the military industry relies so much takes place in the research universities of the First World. It is not by chance that Raytheon,

the high-tech company that designed and produces the Patriot missile, was funded by Vannevar Bush, the enlightened electrical engineer who shaped American science during and after WWII, and who presided for many years the Massachusetts Institute of Technology.

The dream of "quick fixes" --either military or industrial-- is a typical delusion of the Third World. The Argentine military were responsible for skewing for decades the country's science and technology budget for funding their nuclear projects, and it is now plainly evident that the whole enterprise has been useless. Began by a typical military Third World leader (Peron) and continued under all the military regimes that followed, the nuclear program drained national and human and financial resources for making atomic weapons. While the rest of the scientific establishment was decimated by political repression, budgetary scarcity and short-sighted policies, the Argentine Nuclear Program continued to grow and expand. In fact, it has been a most successful mechanism of scientific underdevelopment. Argentina is still devoid of experimental physics, practically all its mathematicians are abroad, and the technical and commercial spin-offs have been small and utterly insignificant.

9. The collaboration going on now between Monsanto and CINVESTAV in Mexico one of the few (if not the only) real research joint venture between a TNC/PACS and a Latin America laboratory involved in plant molecular biology.

10. TNC/PACS have their significant share of responsibility in the invention, diffusion and consolidation of pseudobiotechnology, one

of the "adequate" technologies that helped so much in the destruction of the development of molecular biology in the Third World.

11. When constructing the operon theory of the regulation of gene expression in procaryotic cells, F. Jacob and J. Monod argued that the logic of the signal/receptor pair is such that only the existence of the signal needs to be experimentally proved. Once the signal is identified and chemically isolated, the existence of its receptor follows logically (a signal must necessarily interact with a receptor structure which first recognizes and then mediates the transduction needed for eliciting a response). Therefore, the isolation of the receptor is a purely chemical (not logical) problem.

TNC/PACS ideated, constructed and disseminated powerful and pervasive signals, which form the messages of the propaganda blitzes of the "Green Revolution" and pseudobiotechnology. The receptors of these signals were and are the politicians, the administrators, the lawyers, the scientists, the technicians, the farmers, and the academics of the Third World.

12. "The knowledge derived from the work of the human genome initiative will undoubtedly revolutionize biology and medicine and will greatly affect many other social and natural sciences. If the Third World countries does not share in this project, the gap that separates their development from that found in the industrialized countries will widen even more. To prevent this, we must be

directly involved in the research, must have access to the knowledge that will be generated, and must train and prepare our young people to use and interpret this new knowledge...[T]he study of the human genome is a global task that needs the efforts of scientists from all regions. It is a noble task that should unite us and increase our respect for humankind." [24].

13. "Pseudobiotechnology" --also known as "Third World" or "backyard" biotechnology, is a supposedly altruist odyssey, rigorously non-competitive, deeply "nationalistic" enterprise that aspires to solve all the medical, veterinary and agricultural problems indigenous to the Third World through the use of some of the conventional (and often trite) technologies of molecular biology [11].

14. There is an ethic of advertisement, which requires that no lies are said, written or shown about a product. That is, the propaganda effort must be based on facts. Volvo recently had to withdraw a T.V. advertisement which showed one of its cars emerging unscathed after the impact of a truck after it was proved that the experiment never took place. The company was socially forced to change its advertisement agency. Even more recently, Genentech filed suit in federal court against SmithKline Beecham, alleging that the latter are falsely advertising the merits of its clott-dissolving drug, Eminase, compared to Genentech's Activase.

15. Technology transfer is a misleading term, because it conjures

the idea that there is really a movement of knowledge. The only thing that is transferred is the legal property of a process, but the knowledge is only shared. If the recipient of technology is not actively involved in the creation of knowledge and does not interact with the purveyor of technology to improve, modify and eventually supersede the technology, its role is reduced to that of a brainless user.

16. The case of Argentina illustrates this divorce between science and technology. Professor L.F. Leloir (Nobel Laureate) discovered the role of sugar nucleotides in the mechanism of biosynthesis of complex sugars, including starch, and his laboratory contributed fundamental clues to the biochemistry of this polymer. However, the agricultural research establishment of Argentina --a country that has been for many decades a substantial exporter of wheat and corn-- never paid any attention to the genetics of starch synthesis. The divorce between science and technology is also evident in the field of protein chemistry. The single Argentine laboratory that mastered classical protein chemistry studied with great success the relation between primary structure and function of growth hormone, but nobody in the country was involved in the study of wheat seed reserve proteins, the fundamental component of flour which conditions the quality of the dough. The scientific leaders of the molecular biology of wheat proteins are in the U.S. and the U.K, and Israel scientists have succeeded in expressing some high molecular weight glutenins in *E. coli* (1 liter of culture producing 10 to 20 mg of protein, with a purity of 95 per cent).

17. The periphery is supposed to develop through industrialization programs designed to achieve scale economies for the standardized production for mass markets. Thus, mass production of industrial commodities is transferred from high-wage to low-wage countries, and small firms that use relatively undereducated and/or uneducated labor and traditional technologies to serve local niche markets are encouraged. These endeavors have a very low science content, and neither need nor induce the induce of a strong scientific public and corporate sector. The expansion of the knowledge base has never been a target in "development plans," and the peripheral industrial corporation lacks the essential characteristic of its central counterpart: being a research consumer and a research sponsor [27].

18. The social sciences often suffer from what A. Sen calls "descriptive penury and factual irrelevance." Descriptions can be accurate without being useful. It is true that TNC/PACS take Southern germplasm free --in what may be considered a fraudulent expropriation --but it is also true that the germplasm-rich countries are not even trying to create the science needed for realizing the potential value of their expropriated germplasm.

On the other hand, arguments invoking the rights of "poor farmers" of their seeds might sound concerned and humanitarian, but are eminently reactionary. Subsistence farming and their associated "poor farmers" should have disappeared long ago from the South, and their very existence is in itself a case of grave violation of human rights.

19. The workers in capitalist societies are formally free to sell their labor power in the marketplace. Scientific progress and technological change ultimately marginalizes them from production, and many of them become jobless. Third World countries are formally free to export cash crops and become the homes of maquila industries. Their scientific weakness leads them to suffer from the deteriorating terms of trade and eventually will become jobless because of the biotechnological substitution of their cash crops.

20. The evolution of the Argentine biomedical sciences helps to illustrate this point. B.A. Houssay (Nobel laureate) always worked in Buenos Aires and had several top quality students: L.F. Leloir (Nobel laureate), E. Braun Menendez, A. Stopani, A. Lanari, and E.D.P. De Robertis. Braun Menendez's most distinguished students are professor in the U.S., including J. Zadunaisky (N.Y.U.) and O. Mogueilevsky (Dartmouth). C. Milstein (Nobel Laureate), a student of A. Stopani, was forced out from Argentina and works in Cambridge, U.K. O. Stutman (Cornell) is a student of A. Lanari. De Robertis's most talented students of De Robertis are professors in France -- H.M. Gerschenfeld (Ecole Normal Superieure)-- and the U.S. --D. Sabatini (NYU), A. Lasansky (N.I.H.), and L. Salganicoff (Penn).

21. It is important, however, not to idealize the connections between the TNC and the First World academic sector. While most of the TNC/PACS have a long tradition of positive and intimate contact and collaboration with research universities (Du Pont de Nemours with Harvard University and Monsanto with Washington University) and others have recently followed their example (Hitachi with

University of California at Riverside, Hoechst and Sischeido with the Massachusetts General Hospital/Harvard Medical School, Fidia with Georgetown University Medical School), this is not the rule in the physical and mathematical sciences, which traditionally received a more consistent backing from the military than from the industry.

22. The "research" activities of some laboratories of the University of Buenos Aires consisted in running chemical analysis of oil seed species for transnationals involved in the production and commercialization of edible oils. These laboratories were also involved in the training of technicians for the transnational's chemical and agroindustrial subsidiaries. The professors who run this labas were acclaimed by all sectors of the political spectrum for their devotion to "industry-academic" ventures of "national" interest. The result of this policy was the withering of organic chemistry in the University of Buenos Aires.

23. Occasionally the members of the establishment are also worthy scientists, and the awards reflect the real merits of their work, as it was generally the case with the Bunge & Born prizes in Argentina. Nobelists B.A. Houssay, L.F. Leloir, and many other distinguished scientists such as E.D.P. DeRobertis, A. Lanari, A. Parodi, A. Paladini and L. Santalo were recipients of this prize. Yet this example is an exception rather than the rule in the Third World.

24. The classical paradigm of this interaction is that of Prof Jeffrey Wyman and Italy after WWII. The presence of Prof Wyman at

Rome had an extraordinary catalytic effect on Italian macromolecular physical chemistry, and strongly contributed to the formation of a strong and sophisticated school of protein chemists of international renown.