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The Role of Biotechnology in the Agro-Food System and the Socialist Horizon

I. Introduction

In all class societies, the dominant problem for any ruling class is the production and appropriation of surplus product. Under the capitalist mode of production, this issue is essentially determined by the class appropriation of the means of production and subsistence. The ensuing process of 'primitive accumulation' concerns not only the original, historical establishment of the capitalist mode of production (CMP), but also informs its evolution and the contemporary process of capital accumulation.

In capitalism, as in all societies, the production and provision of food is of fundamental importance, not only because it directly affects social welfare, but also because it essentially determines the reproduction costs of the direct producers themselves, and hence the potential of producing an economic surplus. The role of technology, which should be conceived as a key instrument in the metabolic relation between human beings and nature, is also of paramount importance in determining, historically,

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the possibilities for surplus production.[1] By increasing labour productivity, the development of technology has greatly reduced the cost of all production, as well as the reproduction cost of labour-power, and thus it has immensely affected surplus production. Therefore, the development and application of modern technology, particularly in the context of capitalist agricultural and food production, has significantly determined the potential of capitalist accumulation, not only in the agricultural and food sector, but also in the economy as a whole.

According to one interpretation, the historical evolution of capitalist agriculture has proceeded through three successive agricultural revolutions, associated with specific technological innovations. The first, associated with improved techniques of crop rotation, manuring, drainage, and livestock management, is closely related to, and indeed laid the foundations for the industrial revolution in the seventeenth and eighteenth centuries. The second, in the period 1830–80, is characterised by the growth of the fertiliser industry and the revolution in soil chemistry, largely associated with the work of the German agricultural chemist Justus von Liebig. The third agricultural revolution, in the twentieth century, related to mechanisation, genetic improvement of plants and intensive use of agro-chemicals, is not however fully specified, in terms of time and content.[2] I shall return to this point.

Technology has been used throughout the history of capitalism not only as a means of competition and an instrument for exploiting labour-power and natural resources, but also to face specific problems such as rising indebtedness and hunger in the so-called Third World or the containment of social insurgency. The technological fix, for example, familiarly known as the 'green revolution' (GR), which was promoted by international organisations and some advanced capitalist countries, and utilised mainly in underdeveloped countries during the early post-war period, was aimed at confronting the increasing poverty and the potentially anticapitalist struggle in these countries. However, it has led to an intense controversy insofar as it became obvious, after two or three decades of application, that it had largely failed to meet

[1] As Marx points out, 'technology discloses man's mode of dealing with Nature, the process of production by which he sustains his life, and thereby also lays bare the mode of formation of his social relations, and of the mental conceptions that flow from them' (Marx 1967, I, p. 372). See also Foster 1999.

[2] See Foster 1999.

its initial objectives, while it had increased social differentiation and inequality, and had given rise to considerable environmental problems.[3]

As I argue below, the limited success of the GR and the aggravating conditions of capitalist valorisation and accumulation have, during the last two or three decades, given rise to what is often called a 'biological revolution' (BR). Modern biotechnology has far-reaching implications, not only for agriculture and food production, but also for industrial production, health care, and the environment.[4] The specific developments in biotechnology create entirely new conditions for the accumulation of capital, and give rise to new economic contradictions and significant social disruptions. These new conditions, in turn, give rise to a debate, particularly insofar as the agro-food system is concerned, regarding the social and environmental implications of the potential applications of biotechnological innovations, as well as the ethical dilemmas arising especially in the case of transgenic or genetically modified organisms (GMO).[5] An adequate analysis, from a political-economy point of view, is therefore urgently required in order to unravel all these contradictions and dilemmas, and clarify the newly emerging social perspectives.

Contrary to the prevailing, deterministic, and indeed reified conception of technology,[6] according to which technology is an exogenous and socially neutral factor, with unproblematic and positive implications for society as a whole,[7] I follow a recently developed, more dialectical and critical, approach

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[3] See Cleaver 1972; Kloppenburg 1988, pp. 157–61; Shiva 1991; Liodakis 1997; CornerHouse 1998.

[4] While biotechnology is broadly defined as 'any technique that uses living organisms (or parts of organisms) to make or modify products, to improve plants or animals, or to develop microorganisms for specific uses' (as cited in Kloppenburg 1988, p. 1), modern biotechnology is characterised by a more prominent role of genetic technologies, achieved through a recombinant DNA transfer (gene 'splicing'), which allow profound transformations in living organisms and the crossing over of the conventional walls of speciation. The GMOs of modern biotechnology are often considered to constitute a 'second nature', with potentially contradictory and highly unpredictable implications (see Goodman and Redclift 1991, pp. xvi, 250; King 1997; Rifkin 1998, Chapters 3 & 7; Spence 2000).

[5] See Kenney and Buttel 1985; Ahmed 1988; Meagher 1990; King 1997; CornerHouse 1997, 1998; Middendorf et al. 1998; Altieri and Rosset 1999; Burstyn 2000; Magdoff et al. 2000; Spence 2000.

[6] This reified conception of technology implies that a social relation of people involved is fantastically presented 'as a relation between things'. See Marx 1967, I, p. 72; and Berlan and Lewontin 1986.

[7] See Szarka 1999; NFSD 2001.

to technological development. This new approach considers technology as an endogenous, socially shaped, and non-neutral factor of social development.[8] On the basis of this account, it becomes clear that the real challenge facing contemporary societies is not just the level of development of technology, or the access to and the proper use of it, but concerns, on the one hand, the social shaping and orientation of technology, along with the class-differential impact of its use, and on the other hand, the required social reorganisation (transformation) which would ensure both an appropriate development of technology and a rational and full utilisation of available technology for the benefit of society as a whole.

Focusing on the role of biotechnology in the context of the agro-food system, I will attempt in this article to tackle some of these challenges. Starting in Section II, I analyse the socio-economic conditions of the rapid development and integration of the agro-food system, and attempt to explicate both the historical context within which modern biotechnology arises and the relations regarding its control. In Section III, I critically examine the controversy regarding the new promises as well as the new problems generated by the use of biotechnology in the agro-food system. In Section IV, I investigate the implications of intellectual property rights (IPRs) associated with biotechnological innovations, regarding distribution, social welfare, and the environment. In Section V, I examine more specifically the relevant global regulation and class conflict. Finally, an attempt is made, in Section VI, to outline an alternative social perspective superseding the impasses of contemporary economic and technological development, particularly insofar as biotechnology and the agro-food system are concerned.

II. The formation of the agro-food system and the socio-historical context of modern biotechnology

II. (i) *World capitalism and the formation of the agro-food system*

An adequate investigation of the historical development of agriculture and the formation of the modern agro-food system requires a theoretical framework adequate to the historical development and periodisation of capitalism. It

[8] See Mackenzie and Wajcman 1985; Kloppenburg 1988, pp. 128, 281; Noble 1995; Liodakis 1997; Magdoff et al. 1998, 2000; Middendorf et al. 1998.

will be sufficient for my purposes to start with the familiar periodisation of capitalism, according to which the competitive (*laissez-faire*) form of capitalism, which lasted until the end of the nineteenth century, is succeeded by monopoly capitalism or imperialism.[9] I will argue, further, that a new stage in the development of capitalism is emerging during the last few decades.

There has been a move from the formal subsumption of labour prevailing in the early phases of capitalism, and the predominant role of absolute surplus-value extraction in the competitive stage of capitalism, to a real subsumption of labour, particularly in the monopoly stage of capitalism, with a predominance of the relative surplus-value extraction. As the inherent limits of capitalist valorisation come increasingly into effect, and the accumulation crisis intensified since the 1970s, the required restructuring of capitalism, which is currently underway, both presupposes and dialectically implies the real, or indeed the total subsumption, not only of labour, but also of science and nature itself under capital. And it is this crucial new element which constitutes the landmark of the emerging new stage of capitalism. The fundamental restructuring of capitalism arises, not only from the need to overcome accumulation crisis, but also from the associated trend of international expansion, the collapse of the 'socialist' bloc, and the potentials generated by new technologies.

This new stage of capitalism is dialectically superseding imperialism, while maintaining most of its essential characteristics. It encompasses: (a) a fundamental technological transformation,[10] (b) the subsumption under capital of both labour and the other fundamental resources of production, and hence a new mode of reproduction of the capitalist relations of production, (c) an enormous concentration and conglomeration of capital, a rising vertical and horizontal integration, and an increasing transnationalisation of the accumulation process, and (d) an increasingly transnational socialisation of production, a corresponding transformation of state forms and social authority, and a rising authoritarianism, which is intrinsically related to the new structural characteristics of capitalism.[11] This latter characteristic trend of the new stage

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[9] See Fine and Harris 1979, Chapter 7.

[10] According to Noble (1995, pp. xi, 3), this technological transformation, along with the structural transformations of capitalism during recent decades, lays the basis for a second industrial revolution, comparable only with the classic industrial revolution of the eighteenth century.

[11] Although the crystallisation of the new stage of capitalism and its christening is as yet an open question, it might be characterised as the stage of *transnational capitalism* or, as suggested elsewhere, *totalitarian capitalism*. The latter polyvalent term is meant to imply both economic integration and an authoritarian political and social practice.

of capitalism, under constitution, does not imply the elimination of the nation-state. As is increasingly recognised, however, it implies an increasing transformation and internationalisation of the state, which is combined with a rising transnational state, constituted by international organisations, such as the WTO, World Bank and IMF, capitalist groupings, such as OECD and G8, and other economic forums.[12] All state forms, whether national or transnational, reflect the present structure and the dynamic restructuring of capitalist production and social classes, on a national and international level, while playing an instrumental role as regards a specific restructuring, consonant to the overriding strategic options of transnational capital.

It is within this framework that I consider the development of agriculture and the formation of the agro-food system in particular. Agriculture and the agro-food system are part and parcel of the overall development of capitalism. As an organic relation of a part to the whole, they are largely determined by, and actively contribute to the overall development and transformation of capitalism.

As is familiar, the development of capitalism in agriculture has historically faced serious obstacles in all countries, relating either to the peculiarities of nature and the biological element of agriculture, or to the nature of the pre-existing forms of production and the sociohistorical conditions prevailing in each particular country or region. These difficulties concern, in the first place, the relatively high natural risks of agriculture, the impossibility of manipulating the production period or drastically reducing production times, as well as the disadvantages of overspecialisation (monoculture) in agriculture, compared to industry, and the fact that agriculture is not equally susceptible to mechanisation.[13] As Marx has pointed out,[14] the requirement of land as a basic means of agricultural production and the role of landed property and ground rent constitute another potentially significant barrier to the development and accumulation of capital in agriculture.

Despite all obstacles, capitalism has finally penetrated and developed, to a varying degree, in the agricultural sector of all countries. These obstacles, along with a restricted availability of a relatively cheap labour force in the agricultural sector, have usually induced the development and expansive

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[12] See McMichael and Myhre 1991; Robinson and Harris 2000; Radice 2000 and 2001; Robinson 2001.

[13] See Goodman and Redclift 1982, pp. 10–14; Lewontin, 1998.

[14] Marx 1967, III, p. 639.

application of modern agricultural technology. This technology, whether in the form of mechanisation or in the form of chemical fertilisers, new and improved varieties of seeds, or other industrial inputs used in agricultural production, has usually a capital-intensive and labour-saving character, and has historically reinforced class differentiation and capitalist development in agriculture.

The alienation of direct producers from land, arising from 'primitive accumulation' in agriculture and the class-differential implications of agricultural technologies, along with an overexploitation of natural resources, the increasing polarisation between urban centres and the country, and the social and ecological impact of new technologies have progressively led to a metabolic rift between nature and society, and made it evident, already in the mid-nineteenth century, that a rational agriculture is incompatible with capitalism. In both small- and large-scale capitalist agriculture, as Marx points out, 'exploitation and squandering of the vitality of the soil . . . takes the place of a conscious rational cultivation of the soil as eternal communal property, an inalienable condition for the existence and reproduction of a chain of successive generations of the human race'.[15] As it is further pointed out,

> all progress in capitalist agriculture is a progress in the art, not only of robbing the labourer, but of robbing the soil; all progress in increasing the fertility of the soil for a given time, is a progress towards ruining the lasting sources of that fertility. . . . Capitalist production, therefore, develops technology and the combining together of various processes into a social whole, only by sapping the original sources of all wealth – the soil and the labourer.[16]

Marx concludes, more specifically, that 'the capitalist system works against a rational agriculture, or that a rational agriculture is incompatible with the capitalist system (although the latter promotes technical improvements in agriculture), and needs either the hand of the small farmer living by his own labour or the control of associated producers'.[17]

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[15] Marx 1967, III, p. 812.

[16] Marx 1967, I, pp. 506–7. In contemporary capitalism, as Passet 2000 points out, the potential for protecting nature turns into an overexploitation. Although modern technologies allow, theoretically, for an economising of space, labour, materials and energy, elements necessary for the production of a product, the competitive mania towards greater quantity offsets this potential entirely.

[17] Marx 1967, III, p. 121. See also Burkett 1999, pp. 27, 119, 128; Foster 1999 and 2000; Magdoff et al. 2000.

In contemporary capitalist agriculture, two developmental trends are clearly remarkable. The first concerns the appropriation, by modern industry, of particular aspects or functions of agricultural productive activity, which are then re-introduced to agriculture in a commodified form,[18] while the second relates to the extensive substitution of agricultural by synthetic raw materials.[19] The first trend is reflected in the increasing dependence of farmers on pesticides and chemical fertilisers, as well as on commodified seed and genetic material. These elements have been rapidly converted from public goods and means of production controlled by the direct producers, into commodities ('inputs') controlled by big transnational corporations (TNCs). As Kloppenburg points out, 'the productive activities that are taken off-farm are . . . those that reproduce the farmer's means of production'. He concludes that, this process erodes the autonomy of the petty commodity producer and, moreover, '[b]y binding the farmer firmly to off-farm capital, [it] not only allows for the extraction of surplus value in industrial settings but also sets the preconditions for the . . . indirect exploitation of the farmer'.[20] Although both this and the second trend ('substitutionism') tend to reduce the scope of productive activity and the opportunities for investment of capital in agriculture, they certainly open a broader scope for the investment of capital in other sectors (mainly in industry) and facilitate the overall accumulation of capital.

The social and economic restructuring in both agriculture and industry, which has been partly brought about by new technologies and the two development trends outlined above, has rapidly led, during the last few decades, to a tight integration of industry and agriculture.[21] This integration has led to the formation, development, and transnationalisation of the so-called agro-food system, although biophysical and social specifications and the changing significance of particular commodity chains have put some

[18] Although this trend has recently acquired an overriding importance, it is not an entirely new phenomenon. Marx was already pointing out that 'the machine-making factory, external trade, crafts, etc. appear as needs for agriculture. . . . Agriculture no longer finds the natural conditions of its own production within itself, naturally arisen, spontaneous, and ready to hand, but these exist as an industry separate from it. . . . This pulling-away of the natural ground from the foundations of every industry, and this transfer of the conditions of production outside itself, into a general context – hence the transformation of what was previously superfluous into what is necessary, as a historically created necessity – is the tendency of capital' (Marx 1973, pp. 527–8).

[19] See Goodman et al. 1987; Fine 1994.

[20] Kloppenburg 1988, p. 34.

[21] See Goodman et al. 1987; McMichael and Myhre 1991; Goodman and Watts 1994.

limits on an undifferentiated process of globalisation of this system.[22] The agro-food system comprises both a vertical upstream integration, including the production of all inputs used in agricultural production, and a downstream integration encompassing the processing of agricultural products and the production and distribution of food up to the end of the chain where agricultural and food products or services are offered for consumption.[23] This process of integration, however, has been most uneven, at both a national and international level, reflecting the relevant inherent trend of the CMP itself.[24] Through this integration, agricultural production has approached more closely the characteristics of industrial production, while the application of new technologies has largely contributed to overcoming the obstacles of capitalist development posed by nature itself and the biological element of agricultural production. Thus, agricultural and food production has become less dependent on land, and susceptible to further industrial manipulation, while its labour requirements have also been greatly reduced.

Several attempts have been made so far to delineate the configuration of food production and consumption on a global level. Although I cannot expand on this issue, it is worth noting the regulationist approach proposed by Harriet Friedmann, which, however, suffers not only from all defects of a structuralist and paradigmatic methodology, but also from a superficial abstraction from the overall capitalist context.[25] Moreover, it largely departs from a truly materialist and dialectical understanding of both agricultural (food) production and technology. It is also remarkable that the classical agrarian question (emphasising land tenure) is recently undergoing a radical change, within the context of increasing globalisation. In view of the crisis of developmentalism and productivism, the current re-configuration of the agrarian question, assigning a prominent role to food safety and ecological sustainability, seeks

[22] See Goodman 1997; Raikes and Gibbon 2000.

[23] It is characteristic of the agro-food system, in the more advanced countries, that the significance of farming itself has drastically declined, and now it accounts for only about 10% of the value added, while the lion's share has been gained by transportation, processing, and marketing activities (see Lewontin 1998).

[24] It should be added that this unevenness of development and the limits imposed on the integration of the agro-food system are also due to the heavy dependence on the 'organic' nature of food, both in terms of its consumption and as a product of agriculture (see Fine 1997). This 'organic' character of food also explains the relative autonomy of the agro-food system.

[25] See also Brenner and Glick 1991; Goodman and Watts 1994.

to reverse the anti-agrarianism of the dominant development paradigm.[26] A crucial question, arising within this context, concerns the role of the BR and the particular conditions for its development, as well as its significance for the transformation of the agro-food system.

II. (ii) *The historical context and the causes of revolution in biotechnology*

As I have already noted, although the application and spread of the GR in the early post-war period led to considerable labour productivity increases and allowed a systematic utilisation, or occasional overuse, of certain natural resources, it failed to eliminate famine in the Third World, while it encouraged greater economic and social concentration, as well as ecological degradation. It was also restricted to certain climatic zones only and those countries or regions with sufficient fertile lands and water resources. Eventually, the GR experience has forcefully led to the conclusion that it was impossible to face adequately what was essentially a social problem by merely technical means.[27]

The GR comprised a combined use of agricultural machinery, extensive utilisation of irrigation, fertilisers, pesticides, and most importantly of improved hybrid seeds. Although American companies had brought hybrid corn to the market already in the period 1920–30, it was only in the context of the GR that the use of commercialised hybrid seeds expanded rapidly.[28] Hence, the increasing dependence of farmers on the companies distributing these seeds or other related inputs set the ground for the first stage in the conflict between the two sides. Moreover, insofar as this dependence of farmers on commodified inputs increases, and these inputs are ever more concentrated in the hands of a few TNCs, the cost of agricultural production rises sharply and this drives thousands of small or medium farmers to bankruptcy and proletarianisation.[29] Regarding the improved hybrid seeds, as a product of genetic technology (biotechnology), it becomes obvious that they function as a vehicle for social differentiation and accumulation of capital. And, here, the non-neutral character of technology becomes apparent. As Kloppenburg aptly points out, '[t]he development of the hybrid corn cannot be understood as

[26] See McMichael 1997.
[27] See CornerHouse 1998.
[28] See Berlan and Lewontin 1986.
[29] According to Lewontin 1998, 'the essence of proletarianization is in the loss of control over one's labor process and the alienation of the product of that labor'.

the natural outcome of an immanently scientific technical reason. Rather, the very production of scientific knowledge that culminated in hybridization was itself shaped and directed by social relations'.[30]

I would argue that the BR, during the last quarter of the twentieth century, amounts to a dialectical supersession of the GR, insofar as it maintains some of its important features (mechanisation, intensive use of agro-chemicals, etc.), and a constituent element of the more general technological revolution underlying the fundamental transformation of contemporary capitalism. Modern biotechnology opens up a far broader scope than the GR for applications and a profitable investment of capital, even in areas or cases where the GR could not be applied. Biotech products – the result of biological manipulation of natural resources and of genetic engineering of germplasm more specifically – generate far-reaching implications concerning a variety of human conditions and activities. This is the *differentia specifica* of the BR compared to the preceding GR. The problem which now arises concerns the particular causes and the historical specificity of the BR (why biotechnology, and why now?).

I argue that the BR has been the historical outcome, in the current capitalist conjuncture, of a dialectical interaction of the following factors:

(a) Overcoming the current accumulation crisis requires a productivity increase and an expansion of both capitalist property and the scope of production (including agriculture and food production). The current BR represents a modern response to a permanent tension of capitalist agriculture. Contrary to the permanent capitalist degradation of the soil and labour (reducing productivity), the BR aims at an even greater increase in labour productivity and independence from both labour and land. The consumption of low-value genetically engineered food products would also both reduce the value of labour-power and restrain potential social insurgencies (much like the GR), while the utilisation of biotechnology contributes to overcoming the obstacles of capitalist development and encourages this development through class differentiation.

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[30] Kloppenburg 1988, p. 128. See also Berlan and Lewontin 1986. Contrary to a neo-Darwinian positivism or a social Darwinism encouraged recently by the BR, the triple helix, as it has been termed by Lewontin, constituted by genes, organisms, and the environment, entails a vicious circle dynamic of capitalism and makes it clear that modern biotechnology is not, by any means, socially neutral (see Lewontin 2000 and 2001).

(b) The BR is partly stimulated and becomes possible because of a more general development of science and some particular technologies, such as the information technology.

(c) The highly concentrated biotech companies have great profit and investment incentives, insofar as they freely appropriate a huge social wealth in the form of indigenous germplasm. It is also the crucial (genetic) role of germplasm in agricultural production, which enables biotech companies to appropriate a large fraction of the agricultural surplus.[31] Hence they have the power, as well as the need to launch an enormous sales push.[32]

(d) Large capitalist farms encourage a high and concentrated demand for research and biotech products.[33] More generally, competitive concentration and the technological treadmill entail a crucial role of agricultural inputs and seed in particular.

(e) Despite extensive privatisation, the state support of biotech research has been very important, while the creation of the ideological preconditions for the development of biotechnology is equally significant. These preconditions concern, not only the ideology of productivism-developmentalism and a reified conception of technological determinism,[34] but also a false (neo-)Malthusian conception of natural limits regarding the supply of food,[35] and the dominant neoliberal ideology of privatisation, which encourages the expansion of IPRs related to biotech innovations.

The distinctively dialectical-materialist character of my approach derives from the fact that the development and orientation of (bio-) technology is considered to be the outcome of both natural-material conditions and social conditions, in their dialectical interaction.[36] It is also reflected, more specifically, in the fact that the push for an expansive protection of IPRs, discussed below, is interpreted not simply as an exogenous legal-institutional restructuring, but rather as an endogenously induced requirement, dialectically determined and intertwined with the material aspects of nature, (bio-)technology, and social production in the current conjuncture of capitalist accumulation.

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[31] See Lewontin 1998. According to some estimates, and as a result of the BR, seeds are currently accounting, in the developed countries, for about 40% of the total agricultural production cost (see Ahmed 1988).

[32] See Magdoff et al. 1998.

[33] See Meagher 1990.

[34] See Berlan and Lewontin 1986; Noble 1995.

[35] See Burkett 1998a; Foster and Magdoff 1998.

[36] See also Burkett 1998b; Foster 2000, Chapter 5.

II. (iii) *Transnational corporate control of germplasm and the class implications of the BR*

Privatised biotech research, extensive biopiracy, namely free appropriation of indigenous germplasm, and the rapid expansion of IPRs, considered below, imply an increasingly private, and indeed corporate control of germplasm, the most crucial means of agricultural production.[37] The evidence available indicates that biotech innovations have encouraged a vertical integration and merger between the dominant TNCs in the production of agro-chemicals and pesticides, and the companies producing new and GM seeds.[38] This problem of concentration of industrial and social power is further enhanced by some particular innovations.[39] However, instead of the corporate and imperialist control, which entails unequal power relations between centre and the periphery, I would stress more the overwhelming and increasingly transnational capitalist control of germplasm.[40] The question regarding the control of germplasm and competition among relevant corporations, as well as the intertwined imperialist relations between nation-states, is too important to be ignored. However, I would argue that, if such international relations ever had a greater significance and their theoretical conception any greater plausibility, at the current stage of capitalist development these relations (and contradictions) are rather dominated and overdetermined by transnational class relations and contradictions.

This privatised (capitalist) control of germplasm and the active involvement of big TNCs, international organisations, and the most advanced capitalist countries in the attempt to patent and protect biotechnological innovations

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[37] As pointed out by McMichael (1998, p. 108), '[o]n the horizon is an intensification of agrochemical-corporate domination of world food production by six conglomerates involved in genetically engineered food (Monsanto, Novartis, AgroEvo, DuPont, Zeneca, and Dow).'

[38] See Lewontin 1998; Council of Europe 1999.

[39] The development and sale of a pesticide-resistant seed of soya, combining with the same company's pesticide, Roundup, and the attempt to develop and sell 'terminator seeds' by the same company, constitute two very important cases testifying to this point. See CornerHouse 1998; Shand 1998.

[40] Contrary to the *Monthly Review* approach (see Magdoff et al. 1998; McMichael 1998), to a still influential social-democratic approach stressing national regulation, and to most of the 'leftovers' of the traditional Left (all stressing national contradictions and corporate capital), Radice correctly points out that, 'an effective socialist movement has to deal directly with the realities of globalization, and not just attack its ideology, by braking with the nationalism that has shaped left politics in the twentieth century' (2001, p. 125).

constitute a major driving force behind the process of restructuring and transformation of the agro-food system. Understanding primitive accumulation as the transformation of the means of production into capital,[41] I consider the BR and the new knowledge of the increasingly privatised agricultural science as 'an essential component of the contemporary dynamic of primitive accumulation in the agricultural sector'.[42]

I conclude, therefore, that the development and application of modern biotechnology in contemporary capitalism implies not only an explosive widening of the metabolic rift between nature and society, but also increasing class tension and exploitation. It becomes increasingly evident, and will become more so below, that the alienation of nature is inextricably intertwined with the alienation of wage-labour, and that the twin emancipation of labour and nature presuppose one another.[43] It becomes also clear that, contrary to a misleading social groups analysis and a related new social movements approach,[44] a class analysis is today more relevant than ever, despite the multiple forms of both the capitalist and the labouring classes, and this element is also crucial for the historical prospects of resolving the social contradictions involved. Today, it is not just the majority of agricultural producers who are increasingly proletarianised. The expanding process of primitive accumulation implies also that the greatest part of the work concerning (privatised) biotech research and management of biological resources, as well as the whole chain of the modern agro-food system, is turned into wage-labour exploited by capital.

III. The controversy over the impact of modern biotechnology in the agro-food system

The development of modern biotechnology has proceeded in parallel with a growing attempt, by the biotech industry and international organisations, to establish IPRs by means of patents, and to advertise and legitimise biotechnology. This attempt has involved a huge and costly public relations

[41] See Marx 1967 I, p. 760.
[42] Kloppenburg 1988, pp. 10–11, 34–5.
[43] See Sheasby 1997.
[44] Such an analysis is bound to lead to a 'minimalist' and an anti-monopolistic approach (see Magdoff et al. 1998, p. 12), which will not be sufficient for a strategy to effectively resolve the contradictions involved.

campaign carried through mass media, remunerated journalism, and also alienated and misguided scientific research. This opinion-making process, combined with multifarious mechanisms for filtering research publications, has largely orientated scientific research and determined the questions that could be legitimately posed in the context of the scientific and technological mainstream. Nevertheless, an extensive debate is currently underway concerning the impact of biotechnology in the agro-food system. Before I proceed to a more specific assessment of this impact of biotechnology, it may be useful to briefly summarise the relevant literature.

According to the advocates of an unrestricted development of biotechnology, biotech and genetic engineering (transgenics, in particular) allow, in the long term, a considerable increase of labour productivity in agriculture, a reduction of production costs, the production of plants and animals with intended characteristics, and hence to the production of 'quality products'. It is also argued that genetic engineering is crucial to feeding the world's increasing numbers of people; helping to restore, through reduced pesticide requirements, a healthy environment and prevent further degradation; and providing farmers and consumers world-wide with more choices and opportunities. Moreover, it is held that, by increasing productivity of the resource-poor farmers, biotechnology increases overall global prosperity.[45]

Regarding the protection of IPRs, biotech and pharmaceutical industries have argued that patents will encourage research and technological development. The advocates of IPRs protection, mainly from the side of the developed countries, have moreover affirmed that 'enhanced and global protection of IPRs would foster technology and investment flows to developing countries, thus promoting their participation in trade and economic development'.[46] The available evidence, however, suggests that such multilateral arrangements are contributing to increased exports from developed countries, while welfare losses are already apparent in developing countries.[47] It is also arguable that 'IPRs protection will constitute a precondition for innovators to license their technology', but as the available evidence suggests, 'innovative firms are growingly reluctant to transfer their technology in an unpackaged form under license and similar contractual arrangements'.[48]

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[45] See Corner House 1998; NFSD 2001.
[46] Correa 2000, p. 23.
[47] See Altieri and Rosset 1999; Correa 2000, p. 23.
[48] Correa 2000, p. 31.

Contrary to the great promises currently offered by the BR, critics of modern biotechnology, and GMOs in particular, correctly point out that enough food is already being produced to provide everyone in the world with a nutritious and adequate diet, and that 'the starving are starving because they are denied access to food – not because there is not enough food'.[49] As genetic engineering will most likely narrow, not increase, the genetic base of food crops, it will threaten the very basis of human nutrition.[50]

The allegedly positive impact on agricultural productivity has also been questioned. According to some estimates, the genetically engineered crops currently cultivated have not significantly increased, and in some cases have indeed lowered, yields compared to conventional varieties of the same crop.[51] The long-run impact on productivity may well be even more negative. Although the employment effects are debatable, the overall labour-displacing and deskilling effects of the products of the BR cannot be seriously doubted.

Despite the socially neutral rhetoric of the advocates of the BR, its pauperising and social-differentiating effects are rather clear.[52] While large and modernised farmers can take greater advantage of these new biotech products, poor farmers face a greater risk of bankruptcy, landlessness, and proletarianisation. This trend is reinforced by international institutional pressures, the shift from the public character of the GR to a rapidly increasing privatisation of research and control in the context of the BR, and a state-induced reorganisation of agriculture 'so as to provide appropriately large production units as factors markets for the new technology'.[53] At the same time, 'genetically-engineered substitutes for tropical cash crops are likely to destroy the livelihoods of many rural poor and aggravate poverty and hunger'.[54]

It is further argued that 'genetic engineering builds new health risks in an agricultural system already crowded with dangers for both farmers and consumers', and that 'in agriculture [it] is likely to have adverse environmental impacts which would undermine the ecological basis of food production'.[55]

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[49] CornerHouse 1998. See also Fine 1997; Altieri and Rosset 1999.

[50] According to some estimates, more than 90% of crop varieties have been lost in the past century, and the decline of agricultural biodiversity has been even more serious during the last few decades.

[51] CornerHouse 1998; Altieri and Rosset 1999; Benbrook 2001.

[52] See Ahmed 1988; Meagher 1990.

[53] Meagher 1990.

[54] CornerHouse 1998.

[55] CornerHouse 1998. It is not accidental, therefore, that a strong resistance movement

More specifically, it is stressed that 'far from patching up problems created by chemical use – soil degradation, water pollution, pest and weed resistance – genetically engineered crops will actually deepen them'.[56] According to some estimates, pests will develop resistance to pest-resistant crops in less than ten years, while 'some novel genes are bound to spread into other plants through cross pollination and affect ecosystems in unpredictable ways'.[57]

Contrary to expectations for 'quality products', the existing evidence and frequent food scandals indicate that the use of modern technology (and biotechnology in particular) leads to a decline in food and environmental quality, and hence to a decline in the quality of life.[58] At the same time, instead of enhanced choice for the farmer and the consumer, modern biotechnology implies not only a loss of biodiversity which restricts future options, but also greater dependence and more limited choice for both farmer and consumer.[59] A brutal illustration of the supremacy of the profit motive is offered in the particular case of the so-called 'terminator technology', which threatens to extinguish farmer expertise in selecting seed and developing locally-adapted varieties – a clear threat to food security and agricultural genetic diversity.[60]

As for patents and the protection of IPRs associated with biotech innovations, it is reasonably argued that 'patents promote secrecy prior to being granted and hinder the free exchange of ideas and information essential for co-operative scientific effort'.[61] The problem is further enhanced insofar as patents protect, as a common practice, 'not only actual fully researched industrial applications, but also potential applications'.[62] It is also argued, more specifically, that the

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has recently developed in India against the import by Monsanto of a GE variety of cotton seed.

[56] Recent research, based on data from the US Department of Agriculture (USDA), shows that, on average, 11.4% more herbicides are used on Monsanto's Roundup Ready (RR) soya, than on conventional soya. The increase was in many cases up to 30% (see Benbrook 2001).

[57] CornerHouse 1998. Opponents of GMOs argue that inadequate tests of genetically engineered (GE) seeds cannot eliminate the risk of seed and ecological contamination (see Altieri and Rosset 1999). The problem increases insofar as many countries either do not have the resources or facilities to test seeds for GE contamination, or the political will to protect their farmers and consumers from genetic pollution. Doctors and scientists also confirm that GE food products could trigger allergies, have increased levels of toxins, and hasten the spread of antibiotic resistance.

[58] See also Kloppenburg 1988, p. 4.

[59] See Kloppenburg 1988, pp. 10–11; Meagher 1990; Middendorf et al. 1998.

[60] See CornerHouse 1998; McMichael 1998.

[61] CornerHouse 1997.

[62] Council of Europe 1999.

push for patents on genes is not about encouraging scientific endeavour and advancing the frontiers in food security and health care, 'it is about ring-fencing knowledge. It is about privatising the very basis of life', while 'nobody has the right to patent information only found with the goodwill and co-operation of the public'.[63] Although a case can be made that the implementation of new IPRs, through international agreements such as the Trade Related Intellectual Property Rights (TRIPS) treaty of the WTO, 'will encourage additional innovation and international dissemination of technologies and products',[64] several cases are presented where the protection of IPRs through patents retards further technological development.[65]

Serious distributional and welfare effects of patents associated with biotechnology are also pointed out in the literature.[66] As Cary Fowler of the FAO has pointed out, '[p]atents are a means of allocating ownership, assigning control, regulating access and apportioning benefits. . . . Patent systems which recognize the contributions of some but not of others are based on injustice and will be unstable, if not unsustainable'.[67] Biopiracy is also often stressed,[68] as well as the geographic distribution of research and development (R&D) and patents, according to which, the underdeveloped countries or regions of the world account for only a small portion of the total R&D expenditure and the patents granted in the area of biotechnology.[69]

With a declining public agricultural research system and an increasing privatisation of research (mainly by big TNCs), there are also systemic forces driving towards a disorientation of scientific research and a misallocation of research funds. An excessive funding of privately controlled research in genetic engineering is sucking up research funds at the expense of research into other forms of agriculture.[70]

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[63] CornerHouse 1997.
[64] As cited in Correa 2000, p. 39.
[65] See Correa 2000, pp. 18–19, 184–5, 193–4.
[66] See Meagher 1990; Correa 2000, pp. 33–7.
[67] As cited in CornerHouse 1997.
[68] See Kloppenburg 1988, pp. 14–15, 169; McMichael 1998; Rifkin 1998, Chapter 2; Martinez-Alier 2000.
[69] See Correa 2000, pp. 39, 173–5.
[70] See Buttel and Busch 1988; Meagher 1990; King 1997; CornerHouse 1998; Middendorf et al. 1998; Rifkin 1998, Chapter 2; Altieri and Rosset 1999; Burstyn 2000.

IV. Further implications from the protection of intellectual property in biotechnology

The development of modern biotechnology is associated with a recent trend towards a greater interlocking of industry, and the agro-food system in particular, with universities and research institutions.[71] This trend, along with a parallel shift towards greater privatisation of relevant scientific research, has contributed to an increasing concentration of economic and social power. The undemocratic research practices stemming from this concentration and the total subsumption of science by capital constitute an increasingly totalitarian social context.[72] Although this environment and the restrictive mainstream thinking in political economy discourage 'fundamental' questions, society does have the right and the scientific community ought to ask, on behalf of society, the crucial questions: questions as to the impact of modern biotechnology, and as to the institutional prerequisites for such a reorganisation of society as will ensure an appropriate development and optimal use of such technology for the benefit of the majority. And what are, within this context, the institutional significance and the social implications of the recent push for wider protection of IPRs associated with biotechnological innovations?

Apart from the issues already discussed in the literature, I stress and briefly discuss five points of major importance, from a political-economy standpoint, in order to evaluate more adequately the implications of biotechnology and the protection of related IPRs. Although I avoid a general, technophobic rejection of biotechnology, it will become clear that, within the prevailing capitalist framework, these five points raise important, direct or indirect, negative implications for social welfare.

First, I stress that the protection of IPRs through patents associated with biotech innovations will tend to retard further technological development and the development of social forces of production. This is not only because of the secrecy prior to granting a patent, during a usually long period of application and consideration for granting a patent, but also after a patent has been granted.[73] Such a patent normally implies a monopolistic right,

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[71] Anticipating a higher stage of industrialisation and a greater subsumption of science by capital, Marx was already pointing out that 'innovation then becomes a business, and the application of science to direct production itself becomes a prospect which determines and solicits it' (Marx 1973, p. 704).

[72] See Patel 1996; Middendorf et al. 1998; Rifkin 1998, Chapters 2, 5; Burstyn 2000.

[73] As Santos and Lewontin point out, 'patents on genes of wide utilization in

which obstructs free access to the use of certain knowledge or productive resource. Thus, scientific research and technological development are seriously retarded. Moreover, insofar as this monopolisation of property rights in the area of biotech knowledge retards the development of productive forces, this would imply a potentially enormous welfare cost for society and for an indefinitely long time. And this is all the more so as biotech TNCs claim and often succeed in obtaining much broader property rights than those actually corresponding to the specific innovation achieved.[74]

Second, there is a serious problem regarding conceptual indeterminacies and the preconditions for granting a patent,[75] as well as the inefficiency of implementing the protection of such IPRs. As has become clear through various processes of preparing or implementing relevant international conventions and agreements, or legal regulations regarding the preconditions for granting a patent, it is often extremely difficult to distinguish between a discovery of something which already exists in nature, which is normally considered not to be patentable, and a true scientific or technological invention, or innovation more broadly, which is considered patentable.[76] A serious problem arises, for example, in sharing the benefits from biodiversity prospecting and in the distinction between traditional empirical knowledge, the state of the art in a particular sector, and what can be considered as the inventor's attempt at 'completing the crucial last mile'.[77] Such distinctions

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agriculture can block the development of new varieties in clear contradiction to the objectives for which the (patent) system was designed' (as cited in Correa 2000, p. 182). See also King 1997.

[74] As pointed out by the Council of Europe 1999, 'extensive patents could in some spheres give rise to an anti-innovative situation in medicine, agriculture and plant breeding'.

[75] It is often suggested that genetic sequences may be considered as 'biological algorithms', which, like computer software, should qualify for protection under copyright (see Ganguli 2000). But regardless of the validity of this argument, what is important is that the combined development, privatisation and utilisation of both information technology and biotechnology leads to an even greater concentration of economic and social power (see also Rifkin 1998, Chapter 6).

[76] See Council of Europe 1999; Szarka 1999; Correa 2000, pp. 177, 182. Greenpeace, for example, has openly accused multinational DuPont (FAO Conference, Rome, June 2001) of a fake 'invention' which led to a tricky patent for high-oil, high-oleic maize [patent EP 744 888], while research has revealed that natural varieties of maize with these same characteristics already exist and can be produced by conventional methods of cultivation. This case has been characterised as clear biopiracy, while Christoph Then of Greenpeace Germany has stressed that 'what DuPont is really trying to achieve is a monopoly on some natural traits of a plant and to deter any other breeder from research and development in this area'.

[77] See Council of Europe 1999; Ganguli 2000.

and application processing require the accumulation and assimilation of an enormous amount of information. At the same time, the long and costly litigation processes and the precarious methods of safeguarding IPRs levy an enormous social cost.[78] And this only to enforce private property rights, while prohibiting free access to a particular knowledge or productive resource!

It is to be doubted whether the inventiveness and the development of productive forces presumably induced by capitalist competition and the protection of IPRs could offset this enormous cost, in terms either of retarding scientific and technical research and the development of productive forces, or of the resources expended for the implementation and safeguarding of IPRs.

Third, there is a crucial ecological problem relating not only to the competitive character of capitalist accumulation and the expanding system of private property, but also to the inefficiency and waste of resources in implementing and protecting IPRs in the field of biotechnology. To the exhaustion of natural resources and the loss of biodiversity must be added the threat of disruption to the organic interdependence of all life forms and all habitats posed by genetic engineering. As already noted, the development and application of biotechnology implies, moreover, a risky widening of the metabolic rift between nature and society. Despite a misleading rhetoric about the productivity and welfare benefits of modern biotechnology, its specific development and exploitation under capitalism tend to undermine the preconditions of any truly sustainable development.

Fourth, there is a great and intensifying contradiction between the social character of the relevant productive forces and the associated relations of private property and appropriation. On the one hand, contemporary capitalism develops an unprecedented socialisation of research, technology, and production, at both a national and a global level. Although these developments proceed unevenly, never before were the development of technology and production in a particular area so dependent on the work of past generations, the work of people in other countries, and the genetic resources transferred from the mostly genetically rich underdeveloped countries of the South. In this sense, the globalisation and socialisation of relevant knowledge and productive forces has developed as never before. On the other hand, there is a strong push towards privatising knowledge and productive (genetic)

[78] See Brush 1996; Szarka 1999; Correa 2000, pp. 185, 194, 197; Ganguli 2000.

resources, and a systemic attempt to protect IPRs associated with biotech innovations. This process, which constitutes a marked stepping up of 'primitive accumulation', is also characterised by a specific valuation approach, reflecting the outlook and the interests of capital. It is indeed characteristic that, while big TNCs in the field of biotechnology and their intellectual allies consider traditional knowledge and the genetic resources extracted from developing countries as a 'common resource' and 'a common heritage of mankind', which should be accessible to all,[79] on the other hand, by patenting biotech innovations, they preclude free access to the knowledge or resource protected, even when it is largely based on that devalorised 'common resource'. In the latter case, they consider their products as private commodities and an object of private property. Capital clearly attributes value only to what it produces itself (through labour and research effort). But this bias and the related blind spots are in-built in the capitalist law of value itself and reflect its historical limitations. According to this law, natural and genetic resources are considered a free gift of nature to capital,[80] while there is an undervaluation of scientific knowledge in general,[81] and a disregard (or underestimation) of the value-creating contribution of the labour of past generations, or even of contemporary peasant farmers involved in the production, selection and improvement of genetic material.[82]

Even though the growing socialisation of production relies on the free appropriation of objectively communal conditions (especially the division of labour, science, and natural conditions), it is a specifically capitalist, exploitative, and alienated socialisation, which is throttled by the existing relations of production and makes the further development of the productive forces inadequate and incongruent for the satisfaction of human needs.[83] In this sense, and according to Marx's analysis, capitalism's 'real barrier' or fundamental contradiction can be expressed not only by the tension between social

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[79] See Brush 1996; Patel 1996; Bhat 1999; Szarka 1999.

[80] See Marx 1967 II, p. 356 and III, p. 745; Burkett 1999, Chapter 6; Liodakis 2001.

[81] See Marx 1967 III, p. 104; Burkett 1999, p. 162. As Burkett points out, '[t]his undervaluation not only inhibits the general development of science but also biases scientific work toward the production of *monopolizable* forms of knowledge capable of yielding rents' (1999, p. 162).

[82] See also Kloppenburg 1988, pp. 185–90; Council of Europe 1999. As plant breeder Norman Simmonds has remarked, however, 'probably, the total genetic change achieved by farmers over the millennia was far greater than that achieved by the last hundred or two years of more systematic science-based effort' (as cited in Kloppenburg 1988, p. 185).

[83] See Burkett 1999, pp. 182–90.

production and private appropriation, but also equivalently by the conflict between production for profit and production for human needs, or by the alienation of the conditions of production *vis-à-vis* the producers and their communities.[84]

Clearly, the contradiction outlined above revolves essentially around the basic contradiction of the CMP, namely the capital-labour contradiction. And technology – as already noted, an outcome itself of prevailing property and productive relations – has always played a crucial role in determining the potential of surplus production and, hence, in property formation and restructuring. In the present circumstances, however, it remains unclear whether this intensifying contradiction will be resolved according to the class terms of capital, with a further extension and deepening of private property, or the class terms of labour and a supersession or abolition of private property.

Fifth, a growing problem arises with intensifying international contradictions related to the development and exploitation of modern biotechnology and, more specifically, with the international division of the benefits from biodiversity prospecting. It is not only that the development and application of modern biotechnology has become a means of competition among countries or geopolitical groups.[85] More significantly, a serious problem is often identified in the germplasm transfer from the biologically rich countries of the South to the advanced capitalist countries, so-called 'biopiracy', and in the appropriation of benefits in cases where genetic resources or information from the former countries are the basis for the development of biotech products in the advanced countries.[86] The dis-possessive valuation outlined above, for poor farmers and the developing countries, and the free appropriation of germplasm by capital, lead Kloppenburg to speak of a sort of 'unequal exchange'.[87] And there is not just a distributional issue here, but also a crucial transformative one. As he points out, more specifically, 'plant genetic resources leave the periphery as a common – and costless – heritage of mankind, and return as a commodity – private property with exchange-value'.[88] He adds further that 'western science made the seed a catalyst for the transformation

[84] See Marx 1967 III, pp. 250, 258, 264; Burkett 1999, pp. 176–80.
[85] See Patel 1996; Correa 2000, pp. 27–8.
[86] See Kloppenburg 1988, pp. 14–15, 152–3, 188–9; McMichael 1998; Martinez-Alier 2000.
[87] Kloppenburg 1988, p. 153.
[88] Kloppenburg 1988, p. 169.

of pre-capitalist agrarian social formations and their integration into the web of commodity relations that characterizes the contemporary world economy'.[89]

It is also often postulated, in international agreements or conventions concerning biodiversity, that the biologically rich (underdeveloped) countries should exchange, 'on mutually agreed terms', the genetic material available in them with modern technology and knowledge developed in the advanced capitalist countries.[90] But the rules of the game are, to be sure, systematically biased.[91] The international problems arising from the utilisation of biotechnology and biodiversity prospecting are, of course, extremely complex and require a more specific treatment.

V. Global regulation and class conflict

Several approaches have been proposed or followed, in an attempt to face some of the international problems arising from the development and patenting of biotechnology, or from prospecting for biological resources. Most of them, without great likelihood of success, have stressed the need of a market reform, or a reform in state regulation and the policies of international organisations. Particular IPRs have also been promoted as a means of compensation and conservation of biological resources and indigenous knowledge, while an unclear concept of *petty patents* has been suggested, in cases where the criterion of novelty for patentability is not strictly met, but that of usefulness is, as a means to protect traditional community knowledge.[92] Because of the high transaction costs of IPRs and their failure in meeting conservation objectives, contracts and subsidisation between producers and users of genetic resources have been alternatively proposed to better ensure conservation, but without a sufficient consideration of the organisational framework.[93] At the same time, regardless of their dubious and debatable character, some NGOs, such as Greenpeace, without essentially questioning the capitalist organisation of production itself, call for a ban of patents on life forms and genetic resources, for specific measures preserving biodiversity, and for a fair division of benefits

[89] Kloppenburg 1988, p. 189.
[90] See Patel 1996; Bhat 1999.
[91] See Bhat 1999; Correa 2000, p. 171.
[92] See Ganguli 2000.
[93] See Brush 1996.

from the use of genetic resources.[94] But, apart from anything else, what is a 'fair division' of benefits?

Even Kloppenburg, despite his thorough and stimulating politico-economic analysis of plant biotechnology, is at a loss, as he sets aside the market failure in setting a relevant price, and searches for 'non-market strategies' that could 'assign a value to something with a recognized utility' and 'establish compensation schedules for appropriation and use of raw genetic material'.[95] He suggests, more specifically, an expansion of the public sector to embrace the production of finished varieties, as a restraint on the activities of private industry and as a means of direct regulatory control over capital.[96] Concerning the issue of germplasm transfer, and reflecting a kind of 'market realism', Kloppenburg comes down against the common heritage principle and the decommodification of all plant germplasm. As he points out, 'paradoxically, when applied to one sector alone, common heritage may exacerbate rather than reduce inequality'. 'Formal institutionalization of common heritage', he argues, 'might simply legitimate the differential abilities of North and South to appropriate, utilize, and benefit from plant genetic resources', and also 'would preclude donor nations from realizing any return benefit – financial or in-kind – from the extraction of the genetic information contained within their borders'. On the other side, he asserts that 'access to the elite lines developed in the advanced capitalist nations might simply reinforce processes of social differentiation among peasant producers, . . . accelerate environmental degradation, and deepen relations of technological dependence between North and South'.[97] Insofar as 'contemporary geopolitical realities' do not 'realistically' allow the pursuit of common heritage, he argues that 'the real problem for the South is not acquiring access to the elite lines of the North but establishing control over and realizing some benefit from the appropriation and utilization of its own resources'. Moreover, he argues that genetic resources should be considered as national property, and that 'establishment of this principle would provide the basis for an international framework through which Third World nations could be compensated for the appropriation and use of

[94] See Greenpeace, 'Who Will Gain Control Over Genetic Resources Vital for Global Food Security?', www.greenpeace.de (4/2001).
[95] Kloppenburg 1988, p. 187.
[96] Kloppenburg 1988, p. 285.
[97] Kloppenburg 1988, p. 287.

their genetic information'.[98] Although he recognises that national property may not be an ideal solution, he argues further for the need of multilateral arrangements, with an understanding that it is a North-South issue, and in the same line of argument that 'the FAO might replace the principle of common heritage with that of national sovereignty, and then specify a legal and institutional structure for managing the exchange of and compensation of plant genetic materials'.[99] '[B]y pursuing a multilateral approach based on the principle of national sovereignty', Kloppenburg notes, 'it may be possible to recognize plant genetic resources as social rather than private property and to preserve the principle of free exchange within the developing world', while 'recognition of national sovereignty and the creation of compensatory mechanisms, on the other hand, would help redress a significant asymmetry in the economic relationship between the advanced capitalist nations and the less developed countries'.[100]

In the light of recent developments in the world economy and of a rapid globalisation (and world socialisation of labour, as pointed out above) one should wonder, in the first place, about the realism of reinforcing national sovereignty.[101] It is also unfortunate that, while Kloppenburg starts from analysing the class-differentiating implications of biotechnology, he does not keep up with a consistent class analysis when he comes to examine the prospects of resolving the contradictions involved. He rather reverts to a geopolitical (North-South) approach, shared by most *Monthly Review* exponents, the flawed character of which becomes more apparent when one considers the social and political feasibility of the piecemeal reformism he suggests. As he implicitly assumes a continuing dominance of capitalism, the political (non-market) arrangements suggested become highly questionable, and while such political arrangements may be necessary, they are not by any means sufficient to confront the actual problem, let alone substitute for real economic functions associated with a specific social structure. As I have argued, modern biotechnology implies a much greater class differentiation and polarisation, while the emerging new stage of capitalism implies an increasing transnationalisation of (capital-labour) class contradictions. The overriding significance of class relations vis-à-vis national relations and contradictions make a class

[98] Kloppenburg 1988, p. 288.
[99] Kloppenburg 1988, p. 289.
[100] Ibid.
[101] See also Fotopoulos 2001.

analysis and political approach, today, more pertinent than a nation-state-centred approach regarding national or geopolitical contradictions. It follows that transnational class control of germplasm is fundamentally more important than imperialist control, commonly understood as a centre-periphery power relation. Thus, Kloppenburg's sociopolitical proposal would most likely fail to tackle effectively the fundamental causes both of the chaotic conditions prevailing in plant biotechnology and in the agro-food system, and of the endemic impasses characterising capitalist production at large.

In the context of the emerging world economic order outlined in Section II, an attempt is, of course, made to regulate international exchange and face up some relevant problems. Despite the uneven and contradictory character of this process, it is worth stressing here the legal and institutional changes imposed world-wide, and the homogenising trends generated by new technological developments and the push towards greater protection of IPRs. Although it is often asserted that WTO country-members are not obliged by the TRIPs Agreement, or by any other international convention, to adopt an expansive approach in respect to patenting substances existing in nature, and that countries may exclude the patentability of plant species, varieties, or biological material isolated therefrom,[102] a growing convergence is noticeable in relevant regulatory laws and biotechnology patent practices around the world.[103] This homogenisation is largely determined by the emerging transnational capitalist state.[104] At the same time, a step-by-step retreat is observed from previous positions or regulations of international conventions, regulatory bodies, and national laws,[105] reflecting the push towards an expansionary and deepening approach to the protection of biotech IPRs, and amounting finally to a shrinking public domain and an expansive domain for private property. Insofar as this increasingly consolidated and totalitarian

[102] See Correa 2000, p. 186; Ganguli 2000.
[103] See Patel 1996; Correa 2000, pp. 177–8.
[104] See Robinson and Harris 2000.
[105] While the European Patent Convention (EPC, 1973), for example, prohibits the patenting of discoveries, and explicitly the patenting of plant varieties and animals (Art. 53b), the European Patent Office (EPO) started granting patents on plants and animals in the early 1990s. It is also remarkable that, while the Parliament of the European Union rejected a proposal of a 'Directive for patents on living organisms' in 1995, it finally enacted in 1998, in response to pressure from the biotech industry, a Directive (98/44/EC on the legal protection of biotechnological inventions) which explicitly allows the patenting of living organisms, such as plants and animals. Subsequently, the Administration of the EPO incorporated (in 1999) the provisions of the EU Directive into its Implementing Regulations. See also Council of Europe 1999.

institutional framework tends to exacerbate the problems outlined in the five points raised in the previous section and reinforce class division and tension in society, considerable objections have also arisen, as well as strong social struggles or movements resisting these developments.[106]

The demands of these opponents constitute some of the main causes of the international movement against capitalist globalisation. Some of the activists, social forces, and NGOs active within this 'anti-globalisation' movement are struggling explicitly against the environmental and health hazards generated by the development and capitalist utilisation of biotechnology, to ensure food security, and stop both patents, or restrictive intellectual property rights, and the sell-out of biological diversity. This highly internationalist movement flourishes, despite the heterogeneity of social and political forces activated in it, and the lack of a clear and coherent class strategy. The search for a strategy, in this context, ranges from a clear market reformism, to a revolutionary call for the radical overthrow and supersession of capitalism. The reformist Left, which tends to predominate within the movement, assumes that the increasing globalisation is the outcome, not of an endogenously induced structural change, but of an exogenous change in policy and the prevalence of neoliberalism, which can be reversed by a sufficient 'pressure from below' and a return to some kind of state regulation. This approach, however, is both utopian and precludes the development of a truly antisystemic movement.[107] I contend that objective developments both in the world economy and in technology make nationalist or social-democratic utopias (and Keynesian regulation) largely out of date, and also that a class approach and anticapitalist perspective is an essential prerequisite of this movement. Although political

[106] An International Undertaking (IU), for example, associated with the Convention of Biological Diversity (CBD, 1992), and the Commission on Genetic Resources for Food and Agriculture (with the participation of 160 countries) are currently active in promoting an international treaty 'to ensure free access for all to the seeds, and their genes, of the world's most important crop species, and to protect these resources from privatisation through patenting and other intellectual property claims'. The EU Patents Directive (98/44/EC) has also come under increasing criticism not only from NGOs and professional interest groups, but also from several governments. See the site of Greenpeace, and Council of Europe 1999.

[107] As Fotopoulos 2001 points out, '[t]he ideas currently adopted by some in the reformist Left that globalisation could be seen as a US attempt to impose its own version of free-market capitalism, which could be resisted by a EU based on a social market, or, even worse by a new kind of "good" nationalism, simply reflect the present demoralisation of the Left and its inclination to believe utopian myths'.

alliances need to be forged in the context of this movement – and these could be forged around issues such as food safety, environmental protection, social and international parity, and the need for reorienting technology in an emancipatory direction – a specific class analysis and strategy is crucially important. Insofar as such a strategy is safely grounded in the material and ontological premises of a working-class perspective, informs all relevant alliances and tactics, and gains hegemony in the 'anti-globalisation' movement, it would ensure both the unity of the movement and an effective transformation of society, departing from a minimalist reformism. But, while the outcomes of this movement remain to be seen, the essential aspects of such a new strategy, more relative to what concerns us here, require closer consideration.

V. Towards a communist strategy for superseding the impasses of social and technological development

In the preceding sections, I have shown that the development and utilisation of biotechnology under capitalism and the expansion of related IPRs have harmful ecological implications and tend to reduce social welfare, and moreover that these developments tend to intensify the internal contradictions of capitalism and exacerbate both social and ecological crisis. The contradictory trends in the development of biotechnology and the agro-food system, along with a careful observation of the more general trends and contradictions of contemporary capitalist society, lead safely to the conclusion that . . . a spectre is haunting the increasingly globalised capitalism of our times – the spectre of communism.

Although a communist strategy to resolve the inherent contradictions of capitalism goes back to the classics of Marxism, it is necessary to reassert today, based on contemporary conditions and focusing on the particular area under investigation, that a communist-oriented transformation of production would be the only true solution of ecological and social crisis, and that any reform within capitalism, even if necessary, will not be sufficient to resolve the problem. A new strategy is clearly required to tackle the fundamental problems arising from the development of biotechnology and the agro-food system, and it is a major task of contemporary political economy, and of science and society more generally, to contribute in shaping such a strategy. Clearly, such a strategy should aim not only at an alternative development of biotechnology and the agro-food system, but also at an overall social

transformation, creating the conditions for breaking the vicious circle of the twin alienation of wage-labour and nature, for the re-establishment of a dialectical unity and a normal metabolism between nature and society, and for an equitable and ecologically sustainable new social world order. The necessity of this transformation stems from the historical crisis of capitalist relations, which should be interpreted as a culmination of capitalism's fundamental contradiction.[108] The limited task of this section will be to simply touch upon the relevant dynamics of contemporary capitalism, the socialist transition to communism, and the contemporary significance of the basic premises of communism (supersession of private property, wage-labour, commodity production, etc.).

It should be noted, in the first place, that the germs of self-destruction or supersession already exist in contemporary capitalism. To give an example, the new developments in modern technology (and biotechnology) and the unprecedented socialisation of relevant labour, which is still, despite a widespread belief to the contrary, highly dependent on nature (and natural genetic material), reveals that the law of value itself and, hence, the labour theory of value are approaching their historical limits.[109] Moreover, as in other sectors of modern technology (such as the cyberspace services), the new social and technological conditions concerning agro-food production make private property counterproductive, hardly operative, and difficult to implement or safeguard.[110] In other words, capitalist property rights (including IPRs), as historically specific capitalist property, reach their limits insofar as the development of the forces of production tends to explode the social integument of private property and the CMP. Despite these trends, however, a radically new social structure could not possibly come about as a spontaneous evolution of the internal contradictions of the CMP, unless the revolutionary class forces struggling for human emancipation and international communism defeat the ruling capitalist forces. It should be taken into account here that the already analysed trend towards an expansion of private property rights leads to a class differentiation and tends to consolidate a specific social structure. The

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[108] See also Burkett 1999, pp. 182–93. As Burkett points out, '[f]rom labor's standpoint, the growing tension between social production and private appropriation appears as a growth of restrictions on workers' individual and collective self-development – *restrictions increasingly not removable within the confines of the wage-labor relation itself*' (1999, p. 211, emphasis in the original).

[109] See also Liodakis 2001.

[110] See also Patel 1996.

total subsumption of science and technology by capital, the expansion of private property and control over the basic productive resources (and genetic material), and the increasing enslavement of wage-labour and independent producers tend to consolidate the opposing social forces in an already evolving revolutionary confrontation. This revolutionary struggle is partly a response to the increasing violence exerted by capital, reflected in the enforcement of an expansionary framework of private property, through national states and international organisations. A more detailed analysis of relevant class forces, though necessary, goes beyond the limited space of the present article.

Both the increasing numbers of farmers and consumers who turn their backs on capitalised, chemical agriculture and the rising movement against capitalist globalisation point to the need for an alternative, radically different agriculture. And there is already enough evidence that such an alternative agriculture exists and works, in some particular cases, or is today feasible, and with it also an alternative ecological technology.[111]

With regard to the process of transition, despite the unquestionable necessity of particular reforms and political alliances, past experience has shown that they must clearly enhance working-class emancipation if they are to ensure irreversibility of social changes. Although market or state reforms and changes in the relevant policy of international organisations may be necessary, they will not be sufficient by themselves to confront the important problems stressed above. The relevant class and social forces constituting the primary agents in this transformation will undoubtedly stem, among other things, from the class-differentiating and exploitative impacts of the development and application of modern science and technology (including biotechnology), and from the social restructuring of the agro-food system, as well as from the growing awareness of the ethical problems and the health and ecological hazards involved.

The role of scientific and technological research is of paramount importance for such a transformation. In what concerns the agro-food system and biotechnology, the need should be stressed for a reconstitution of a vital public sector in science and technology, and a technological development subject to sociopolitical oversight.[112] Participatory democracy may not be a panacea, in this context, but it is certainly an indispensable means for the national

[111] See Rosset 1998; Altieri and Rosset 1999.
[112] See also Middendorf et al. 1998; Bustyn 2000.

and international co-operation required to address production technology issues globally. Scientific research will have the crucial task of contributing to the specific formation and development of the social productive forces, in congruity with the transformed, and qualitatively new, social relations of production.

Taking advantage of positive and negative experience will be valuable in promoting social transformation and shaping the organisation of socialist production. The negative experience from the recently collapsed régimes of so-called 'existing socialism' concerns, among other things, state property and wage-labour alienation, the maintenance of monetary and commodity relations, the fetishisation of modern technology and the development of productive forces, a productivism often implying the disruption of ecosystems, and the persistence of the town/country polarisation. But there is also positive experience and accumulated knowledge, deriving either from this socialist endeavour or from the current ecological and social struggles, which need to be taken into account. These concern some crucial aspects of production, such as the scale of production, the local/global question, and the appropriateness of certain forms of technology.[113] Contrary to the traditional, mechanistic proclamation of the historical necessity for the development of the productive forces, and the dilemma of whether to develop capitalism in agriculture or not, I would also argue that today's resistance to the capitalisation of agriculture may not be an anachronism insofar as it is associated with the need for ecological sustainability and the need to search for 'exit routes' from commodification and the capitalist valorisation process, towards expanding autonomous production and socialism.

Regarding the basic premises of communism, it should be stressed that, insofar as the agro-food system is concerned, the increasing class division and exploitation and the exacerbating social and ecological crisis, generated partly by the increasing privatisation of modern biotechnology and expanding private property rights, could be effectively faced by eliminating the preconditions of social classes, class tensions and exploitation. This could be done not just by banning IPRs associated with biotech innovations, but by eliminating all private property in the means of production and subsistence. It is inadequate to struggle to ensure free access (through the market or otherwise) to seed and germplasm for the farmers. What needs to be established is common

[113] See Magdoff et al. 1998.

control and unrestricted access to all means of production and subsistence, including the results of scientific and technological development. Marx referred to the absurdity of landed property.[114] Today, the absurdity of private property is already becoming apparent, not only in the case of natural resources, but also in establishing private property rights on human genes and particular life forms, or on germplasm and scientific knowledge in general, which are an outcome of a highly socialised process of research and labour.[115] Thus, it would be a reflection of the highest rationality to establish that all scientific and technical knowledge, and all germplasm and means of production are the common property and heritage of all humankind.[116]

The establishment of common access and control over the means of production and subsistence would not only lead to the elimination of social classes and exploitation, but also ensure the elimination of all commodity production. It is certainly not sufficient to fight against the commodification of germplasm and the commercial exploitation of biodiversity. The food system is inextricably involved with the whole nexus of commodity production, and the morbid phenomena prevailing in capitalist production, and in the agro-food system in particular, can only be eliminated insofar as commodity production itself is eliminated. The common accessibility of the means of production will allow a collective organisation of production, by associated or independent producers, and this production would be for use, and would ensure both equitable distribution and ecological sustainability.[117] An attempt to establish state property, or national property on germplasm, as Kloppenburg suggests, would be counterproductive. Not only because it is largely outdated, but also because it is based on, and would tend to reproduce, a particular class structure. More significantly, as it entails state command over the specific resources, and hence the alienation of direct producers from these resources,

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[114] As he stressed, '[f]rom the standpoint of a higher economic form of society, private ownership of the globe by single individuals will appear quite as absurd as private ownership of one man by another' (Marx 1967, III, p. 776).

[115] Marx was already pointing out that '[w]ith the development of social production the means of production cease to be means of private production and products of private production, and can thereafter be only means of production in the hands of associated producers, i.e., the latter's social property, much as they are their social products. However, this expropriation appears within the capitalist system in a contradictory form, as appropriation of social property by a few' (Marx 1967, III, pp. 439–40).

[116] See also Brush 1996; Patel 1996.

[117] See Liodakis 2001.

it would tend to reproduce wage-labour and the capitalist relations of production.

Again, it does not make much sense, indeed, simply to claim access to food (a mere distributional, and highly unfeasible reform!),[118] or to seed, germplasm, and scientific knowledge. As already noted, to make all these possible requires the transformation of all means of production and subsistence into common property for all, and the transformation of social production itself.[119] Such a transformation would also allow an appropriate and ecologically compatible development of technology, and its full utilisation for the benefit of all. It is also inadequate only to claim access (namely, use, possession, or ownership) of certain products or productive resources (such as GMOs or GE food products), insofar as their character, quality and content are the outcome of a socially specific technological development, which may need to change drastically in order to serve human welfare.

As becomes obvious, it is the social preconditions for resolving the contradictions arising from the development of biotechnology and the agro-food system, which broadly 'define' communism (in a non-dogmatic approach). However, my intention in this final section was only to draw the broad lines, and not to offer a detailed description, of a socialist transformation strategy. As the existing trends of capitalist development, the experience accumulated, and the highly globalised class and political conflicts indicate, a socialist transformation perspective would entail a prominent aspect of international regulation and co-operation. International organisations should, of course, be transformed to facilitate, on the basis of social rationality and on egalitarian and ecological principles, the optimum oversight of technological development and distribution of productive resources and social welfare on a world level. This is not to deny, however, the necessity of a local, regional or national regulation, either to ensure direct democratic control, or insofar as it may be pertinent to foster local culture, maintain small-scale local production, and

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[118] It should be noted that famines are caused neither simply by a food availability decline, nor by an inappropriate arrangement of food entitlements. A search for the deeper causes of famine, based on political economy, leads directly to the fundamental characteristics of the CMP (see also Fine 1997).

[119] As J. King also points out, '[d]istribution according to need would . . . be a more equitable and humane mechanism for enforcing access, but cannot be easily instituted while the industry is organized to maximize profits for a tiny sector of the population. Because [biotechnology] was developed predominantly through public investment and broad societal cooperation, the solution is to return it to the public ownership' (King 1997, p. 153).

utilise indigenous knowledge in ensuring ecological sustainability. It is, of course, extremely difficult to foresee the specific social structure and institutional arrangements, but there is a great need to further explore those conditions, which would ensure not only social equity and food safety, but also an appropriate technological development and ecological sustainability. And, moreover, those conditions which would ensure both the incentives (economic or otherwise) for scientific and technological research and development, and the free access of all individuals, collectives, or countries to the natural, or developed, productive resources and the scientific-technological knowledge available. However, past experience, the scientific progress achieved so far, and the emancipating powers of a science whose only goal will be the satisfaction of human needs make this complex task fully attainable. But I should stress again that I do not pretend to offer here a specific blueprint of future society and of particular institutional arrangements. Only real social forces in their historical movement could determine the institutional specificity of such a society.

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