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ON THE POLITICAL ECONOMY OF RISK: FARMWORKERS, PESTICIDES, AND DOLLARS

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The rapid industrialization of world agriculture has been one of the most eventful social and economic transformations taking place in the second half of the 20th century. Today two agricultures coexist in most countries: capital-intensive agribusiness and labor-intensive subsistence farming. In the U.S., the former exploits largely nonwhite immigrant labor and the latter female unpaid labor, surviving as a "second job."

The striking increase of production in industrial agriculture has been accompanied by uneven and irrational development and by a tragic upsurge of mechanical accidents and chemical hazards. Current pesticide use poses a threat to workers and their families, the general public, the environment, and future generations. Acute risks begin to be known largely through farmworkers' exposure, while chronic risks are often inferred from experimental studies but generally are disregarded.

Because of industry's historic neglect of health and environmental hazards, regulation has evolved under pressure from workers and citizens. Regulation is at present the best tool available to shape technological development according to society's needs and goals. Its basic requirements are information, reorientation of public resources, and democratic control. A major obstacle to its implementation is the inequitable social distribution of risks and benefits, within and among nations.

THE INDUSTRIALIZATION OF WORLD AGRICULTURE

Agriculture is one of the oldest of human occupations and, for about 5,000 years, it has been the prevalent occupation. Only since the 1970s, for the first time in history, has less than half of the world's labor force been engaged in working the land (1). Social, political, and technical changes that have reshaped the world since the agricultural revolution at the end of the neolithic era have apparently passed over the heads of the peasants, leaving their working conditions and their daily lives largely unaffected. Yet such changes have slowly but irreversibly modified the relationship of these workers with the land, with the land's (and their) owners, with city dwellers, and with their governments.

The increasing demand for agricultural products by a rising and wealthier urban population has both enhanced the exploitation of agricultural labor and forced the

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introduction of social and technical changes in agriculture. Agricultural machinery began being widely used in industrialized countries at the beginning of this century; agricultural chemicals in the period between the two World Wars, and scientific seeds and feedstocks technology after World War II (2).

Agriculture has thus lost in the more developed countries its characteristics of a labor-intensive, largely manual industry. Capital assets and investments have grown more rapidly in agriculture than in most other industries since 1950.[1] The dramatic increase of agricultural output and productivity has resulted in considerable agricultural surplus in more developed countries (with respect to a slowing population growth) and in massive displacement of the farm population and labor force. Such a process has taken place with varying speed and timing in different countries (see Table 1) and has reached a probable plateau in the most industrialized ones.

In more developed countries as a whole, the share of agriculture in the national labor force decreased only by some 20 percent in the first half of this century, while it was reduced by 75 percent in the third quarter. By 1977, agriculture's share of the work force had become comparable to its share of the gross domestic product (GDP), as shown in the last two columns of Table 1. Hence, allocation of labor (and presumably of capital) to the agricultural sector has become comparable to that to all other sectors of the economy in more developed countries.

Following World War II, peasants, both native and immigrant, were attracted to the booming industrial areas of more developed countries by more stable and higher salaries and by the promise of a better life. The exodus of peasants from farms in less developed countries, in turn, has forced and accelerated industrialization in farming, and it has brought immigrant laborers into the understaffed farms of more developed countries. The war and the ensuing revolutions helped to disintegrate the agrarian societies of less developed countries and the international (colonial) division of labor which rested on them. The cultural, political, and economic ties that kept the peasant masses in place have been increasingly weakened by neocolonial rivalries over markets and resources, by the pressure of liberation movements, and by the advance of industrialization in less developed countries. Unfulfilled promises and various forms of discrimination (in peasants' own countries and in more developed countries) have swollen the urban ghettoes and shantytowns, the unemployment rolls, and the immigration waiting lists. The number of peasants who have left the farms in the third quarter of this century is about one and a half times larger in less developed than in more developed countries.

Industrialization requires an increased social surplus to be used as means of production and involves larger technological inputs in each sector of the economy. Some indices of mechanical and chemical inputs (and outputs) for world agriculture in the mid-1960s, calculated from FAO statistics, are shown in Table 2. The differences in the absolute inputs reflect the large industrialization gap between more

[1] Many authors, following U.S. Department of Agriculture statistics, include the price of land in agricultural investment. A more meaningful comparison of investment trends may be derived from indexes of productivity (output per person-hour, in constant dollars). Between 1950 and 1974, these grew by an average 2.5 percent per year in the whole U.S. private sector, 5.4 percent in agriculture, and 3.2 percent in manufacturing (*Handbook of Labor Statistics*). The corresponding absolute figures for 1974 may be calculated as $7.0, $6.9, and $7.2 per person-hour, respectively.

Table 1

Share represented by agriculture in the world labor force and gross domestic product[a]

	% of Labor Force					% of GDP[b]
Country or Region	1900	1950	1960	1970	1978	1977
Less developed	79.4	77.1	73.1	66.3	60.7	
Brazil		59	55	45.6	39.7	10
Mexico		57.8	54.2	45.2	37.8	9[d]
India		70.6	72.9	69.3	64.6	30[d]
Indonesia		68	67.2	66.3	60.4	31
Algeria		75[c]	65	60.7	51.9	8[d]
Egypt		64	56.6	54.4	51.2	24
More developed	59.4	50.1	30.5	18.5	13.6	
United States		11.2	7.6	3.7	2.4	3
Great Britain		5.1	3.8	2.8	2.2	3
West Germany		22.9	13.7	7.5	4.6	3
Japan		34.3	27	19.7	12.5	5[d]
U.S.S.R.			35.2	25.7	18.1	17
Worldwide	72.1	70.7	58.1	50.9	46.2	

[a] Sources: U.N., *Population Statistics,* and FAO, *Production Yearbook.*

[b] These figures are reported mainly for comparison with the previous column, as comparison provides an estimate of labor and capital intensity of agriculture. A high figure in this column may result from a high farm product or from a low total product (hence a low degree of industrial development), or both.

[c] 1953.

[d] 1976.

developed and less developed countries. As tractor and fertilizer use increased twice as fast in less developed as in more developed countries between 1950 and 1967, one might expect the present gap to be closed between years 2000 and 2050. The difference concerning other agricultural machines, however, such as harvesters and threshers (3.3 million in more developed and 170,000 in less developed countries in 1977), and the relative rates of growth are such that it will take about 400 years to close this gap, if the present trends persist. Capital investments in more developed countries are obviously shifting to more sophisticated technologies, e.g. computerized harvesters, scientific pest management, and genetic engineering, for which no comprehensive data are available. Furthermore, profitable capital investments in Third World agriculture are largely limited to plantations for cash-crops, often controlled by foreign interests. The most populated or less fertile areas are virtually untouched.

Prices of food are largely political, as most governments have been concerned for centuries with ensuring an adequate food supply. Prices of other farm products, e.g. cotton, coffee, and rubber, are determined by international demand (largely from more developed countries) and by the supply policies of transnational companies. Thus production of cash-crops, rather than food, is favored by profit-seeking farmers and by governments in need of hard currency. The global share of the international farm products market represented by less developed countries grew from

Table 2

Selected technological inputs and dollar output of world agriculture[a]

Region	Tractors		Fertilizers		Pesticides		$ Yields[b]	
	No. per 1000 HA, 1967	% Increase 1950-67	Kg/HA 1967	% Increase 1950-67	Kg/HA 1963	% Increase 1950-63	Kg/Ha 1967	% Increase 1950-67
Less developed	1.4	460	10.2	820			1,300	75[c]
Latin America	4.4	430	17.5	700	.22		2,000	87
Near East[d]	1.9	540	10.7	680				87
Far East[d]	.5	1,050	12.7	1,020	.14[e]		800[e]	68
Africa[d]	.6	300	2.4	530	.12		1,200	78
More developed	20	230	68.5	320	1.7		2,600	65
Worldwide	10.7	240	39.7	350		300		67

[a] Source, FAO, *World Agriculture 1970.*
[b] Yield of ten major crops (worldwide), weighted in dollars.
[c] Half this increase was due to expansion of cultivated areas.
[d] Only market economies.
[e] India only.

20 to 23 percent in imports and from 31 to 33 percent in exports between 1973 and 1978. Food produced in less developed countries, however, is largely consumed in the farms—a characteristic of subsistence farming—so that these nations have been increasingly importing food for their cities: a net worth of $3 billion in 1967 and $9.4 billion in 1978 (3). Thus the cash value of the same amount of the same crop to the farmer may be quite different, before it reaches Chicago or Bombay.

Due to the wide range of farm products and their wide regional variation, a comprehensive index of agricultural production is generally based on its cash value. Output indices in Table 2 represent rough estimates of the regional production of some major crops, weighted as the dollar value that such crops would have on the international market, at international prices. By the end of the 1960s, such values were in a 2:1 ratio (5:1 for all industrial commodities) in more developed and less developed countries (4, p. 39). The gross farm product has been growing slightly faster in less developed countries by an average 2.9 percent per year—compared with 2.1 percent in more developed countries—between 1950 and 1978 (1). Thus the relative development gap (ratio MDC/LDC) in agriculture appears to be diminishing very slowly, while the absolute gap (difference MDC-LDC) is still increasing substantially, due to the two-fold differences at the start.

Outputs (cash-weighted) per hectare, however, are growing more slowly in less developed than in more developed countries (1.4 against 2.5 percent per year between 1950 and 1970), as exploitation of marginal areas has been considerably expanded in the former and slightly reduced in the latter (5). Such a trend probably reflects both the fact that most fertile land is within the boundaries of more developed countries and the technical and socioeconomic problems encountered by the "green revolution." The latter has been defined as the adoption by less developed countries of a technological package, including scientifically developed crop varieties, fertilizers, pesticides, and water control, designed to increase farm productivity (6, p. 250). Its promotion has been fostered by promising experimental results and has often favored local (landlords') and foreign agribusiness.

Neither the green revolution nor international aid,[2] however, have solved the problem of hunger in the Third World. The gross farm product per capita by the end of the 1960s in less developed countries was less than one-third the amount available in more developed countries and was growing by 0.5 percent per year as opposed to 1.2 percent in more developed countries (7, p. 47; 8, p. 18). An idea of how the lack of food is translated into economic demand may be inferred from income elasticity figures for 1965-1970, which indicate that, as average income increased by one dollar, 8 cents was spent for food in more developed countries compared with 58 cents in less developed countries with market economies (8, p. 16). More than half the returns of development serve to alleviate hunger for those who have cash.

In conclusion, industrialization has increased technological investments and productivity in agriculture and is proceeding at an unprecedented rate worldwide. The problems generated by rapid industrialization of agriculture include: (a) massive

[2]Between 1954 and 1976, total U.S. food donations, under "Food for Peace," amounted to $10 billion; total agricultural exports were $241 billion and total farm sales $1,300 billion (*Statistical Abstract of the U.S.*).

displacement of rural populations; (b) a potential oversupply of agricultural labor force (and underemployment) in less developed countries and a shortage in more developed countries; (c) a substantially unaltered "development" gap among nations, which is worsening on a *per capita* basis; (d) the persistence of subsistence farming; (e) irrational and unequal development, largely modelled on the U.S. and European experience and hampered by the international division of labor; and (f) economic and social distortions, favoring agribusiness and cash-crops over small farmers and food production.

THE U.S. FARM

In spite of widespread rhetoric praising farmers and their life-style, the statistics of the U.S. Department of Agriculture (USDA) and the United Nations Food and Agriculture Organization (FAO) are much more detailed with respect to farm products than farmers. Farmworkers are acknowledged by agriculture accountants only as an expense item. Farmers are not supposed to work, but to make a profit. The farm is the real subject of these statistics, as though it was offering—like a Biblical lost paradise—its free and beautiful fruits to all men and women of pure heart.

U.S. farms have become both fewer and larger in the last fifty years. A substantially unchanged area of about 1 billion acres was divided into 6.5 million farms in the 1930s, but into less than 2.5 million farms in 1978 (9). Not only has the farm population steadily decreased (a slightly reversed trend emerged in the late 1970s), but its composition has dramatically changed as well (Table 3).

The percentage of the farming population represented by nonwhites was reduced from 16.5 to 6.5 percent between 1960 and 1970, while their proportion in hired farm labor was still at 27.7 percent (now more "Hispanics" than Blacks) in 1977 (9). Between 1940 and 1974, tenants dropped from one-half to one-ninth of the self-employed farmers, while partnerships grew from one-tenth to more than one-quarter of all farms (9). Between 1970 and 1978 a slight decrease in the farm population employed on farms was partially offset by an increase in hired workers, presumably not living permanently on the farms but in labor camps. Most of these hired workers are employed only for short periods, according to seasonal needs. Of the self-employed farmers, about half worked more than 200 days off-farm in 1974 (9).

A substantial, albeit declining fraction of labor is provided by unpaid family workers, who turn out (not unexpectedly) to be largely women. Female proportion declines with the increasing status (and presumably income) of the job. The median monetary income of paid farmworkers was in 1978 about half the median income of workers in all U.S. industries. The average income of all farmer families between 1970 and 1974 (a boom period for agriculture) was still 15 percent below the national average. The proportion of the poor among the farm population has adjusted, after the Black exodus, at the same level as is found in the inner cities: 14 percent in 1973 (9).

On the other hand, farm productivity has increased dramatically. Corn yields that remained for 140 years at 22 to 26 bushels per acre until the 1930s were commonly at 80 bushels per acre by the late '60s (2). Capital assets used in agriculture grew ten-fold between 1959 and 1974 (9). This industry has sold to the international market more than 20 percent in value of all U.S. exports in the last twenty years (between $20 and 30 billion worth of farm products since 1974) (10).

Table 3

Farm population, employment, and income in the U.S.[a]

	1960	1970	1978	% Female 1978	% Nonwhite 1978
Farm population (millions)	15	9.7	8	47.7	6.5
Employed on farm (millions)	4	2.3	1.9	32	
Self-employed	2.4	1.4	1.2	8	2.5
Wage worker	.8	.4	.4	19	
Unpaid family member[b]	.8	.5	.3	65	
Hired labor (millions)[c]		2.5	2.7	24	27.7
Migrant		.2	.2		
Less than 75 days/yr.		1.7	1.7		
Less than 25 days/yr.		1.1	1.1		
Median yearly income ($1000)					
All industries		7.7	13.3		
Agriculture		4.3	7.1		

[a] Source, *Statistical Abstract of the U.S.*

[b] According to USDA, 2.6 million non-hired persons were doing farm work in 1978. Such persons are defined as farm operators doing at least one hour and unpaid family members doing at least 15 hours of farm work during survey weeks (*sic*). Hence, after subtracting *all* self-employed farmers, this leaves a figure of *at least* 1.4 million persons for unpaid family labor in 1978.

[c] USDA figures. However, data from the above surveys indicate 1.9 (1960), 1.2 (1970), and 1.3 (1978) million hired persons (including paid family members) doing at least one hour of farm work during survey weeks.

In order to understand what is going on in U.S. agriculture, large and small agricultural firms must be analyzed separately. We shall define as large those firms that sell $100,000 a year or more of farm products, and as small those that sell less than $10,000 (in constant 1974 dollars, to make use of USDA statistics). Such definitions are consistent with the bimodal distribution of total income per acre according to firm size, which is shown in Figure 1. It must be kept in mind that large and small firms are defined on the basis of individual sales volume and not of acreage. In fact, larger firms not infrequently operate on less land than smaller ones—as is the case, for example, with poultry, vegetables, and fruit farms, compared with farms that sell livestock, dairy, and grains. On the average, however, a large firm controls a ten-fold larger acreage than a small one: 1,814 and 183 acres, respectively, in 1974 (9).

Between 1959 and 1974, the share of small firms decreased from 24 to 18 percent (by one-quarter) of the total cultivated land, while their combined sales fell from 12 to less than 5 percent (by almost two-thirds) of the national farm product. In the same period, the corresponding share of large firms increased from 23 to 29 percent of the acreage, and from 32 to 54 percent of the sales (9). Not unexpectedly, large and small firms also show quite distinct features concerning labor and capital input, as shown in Table 4.

The operating capital investment in all U.S. farms increased by 69 percent between 1969 and 1974. About 6 percent of such investment was paid to farm workers in 1974 (an increase of 38 percent). Larger increases were devoted to feeds, seeds, and

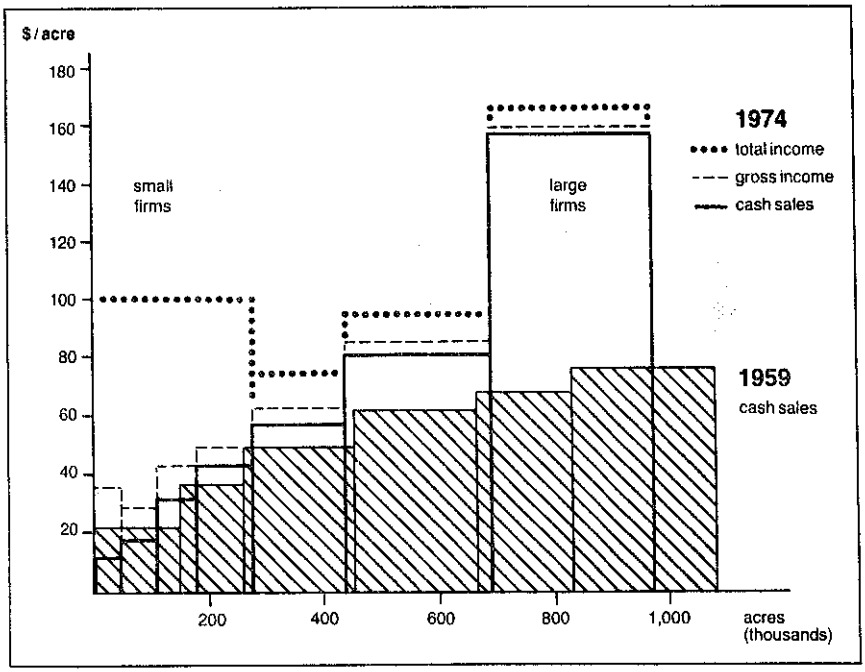

Figure 1. Income of U.S. agricultural sector in constant (1974) dollars, by size of firm. Source, *Statistical Abstract of the U.S.* Gross (farm) income = cash sales + estimated non-cash revenues (home rental and farm products consumed in farm). Total income = gross (farm) income + off-the-farm revenues. Size of firm is defined according to cash sales per farm. Each column includes a group of farms whose individual sales are higher than the group's on its left and lower than: (1959) $5000; 10,000; 20,000; 40,000; 80,000; ∞; (1974) 2,500; 5,000; 10,000; 20,000; 40,000; 100,000; ∞. On the ordinate: average income in $ per acre for each group of firms. On the abscissa: cumulative acreage for each group of firms. The area of each column is proportional to aggregate income for each group of firms.

livestock (the largest item), agricultural chemicals (including fertilizers and pesticides, the second largest production item, showing the steepest increase), and fuel. But the capital intensity of farming was four times higher in large than in small agricultural firms in 1974, as measured by expenses per acre.

While expenses for hired labor were also slightly higher for large firms, non-hired labor (such as the farmers' and the unpaid family workers') is not taken into account. Small farmers in 1974 (according to our definition of small agricultural firms) numbered more than one million and their unpaid helpers probably at least 400,000 (9). If all these working people had been paid a trifling $4,000 a year, their total "wage" would amount to about $33 per acre, hence twice as much as the corresponding labor input in large firms. After such a correction, labor costs of small firms would become four times higher than those of the large ones.

Thus most small farmers in the U.S. tend to behave, with respect to capital and labor intensity, like subsistence farmers in less developed countries. This conclusion

Table 4

Cost of production factors in U.S. farms, by size[a]

Production Factor	% Increase All Firms 1969-74	Billions $ All Firms 1974	% of Total All Firms 1974	$ per Acre All 1974	Large 1974	Small 1974	Ratio Lg/Sm 1974
Hired labor	38	4.6	6.3	4.22	15.13	1.38	10.9[b]
Contract labor and machinery	32	1.8	2.5	1.65	4.10	1.61	2.6
Feeds, seeds, livestock	58	25.4	35.2	23.35	76.61	12.40	6.7
Fuel	62	3.1	4.3	2.85	4.89	3.43	1.4
Fertilizers (commercial)	32	5.1	7.1	4.69	10.24	3.61	2.8
Pesticides	207	1.6	2.2	1.47	4.41	.59	7.5
Other expenses							
Production		9.0	12.5	8.27			
Financial[c]	NA	21.8	30.2	20.04	42.39	12.19	3.4
Total expenses	69	72.2	100	66.36	157.61	35.21	4.5
Cash income (sales)[d]	79	81.5	–	74.91	162	22	7.4
Gross income (farm)[e]	93	98.3	–	90.35	164	51	3.2

[a] Sources, *U.S. Census of Agriculture*, 1974, and *Statistical Abstract of the U.S.*
[b] See text.
[c] Includes depreciation and payments for taxes, interests, and rents.
[d] Total sales receipts for farm products.
[e] Equal cash income plus estimated income from home rental value and value of farm products consumed in the farm. Does not include off-the-farm income.

must be qualified, however, both because the similarity is only a relative one, and because "subsistence farming" in the U.S. and in other more developed countries is made possible (and can afford an incomparably higher standard of living) through activities off the farm, for which the opportunities and the infrastructure are missing in the rural areas of the Third World.[3] Such activities were the source of about 82 percent of the money income of small agricultural firms in 1974 (9). Yet much of these activities presumably involve labor, which is thus transferred from this part (small firms) of the agricultural sector to other sectors of the U.S. economy. Conversely, a considerable volume of capital equipment and supplies is transferred into the (mainly large) agricultural firms from other economic sectors (and accounts for their higher productivity).

The total income—including farm sales, imputed value of local consumption and home rental, and off-the-farm revenue—of U.S. agricultural firms in 1974 (and the farm sales in 1959), by economic size of firm, is shown in Figure 1. As dollars per acre (in constant 1974 dollars) are plotted against cumulative acreage, the area of each column represents the income of each class of firm. "Land productivity," measured in dollars per acre, did not seem to follow in 1974 (as it did in 1959) any "law of diminishing returns." Such a law still applies, however, to technological investments, as shown in Table 4.

A high level of diversification of capital investments (including non-agricultural ventures such as food processing, which are not included in our data), sophisticated financial management, and lobbying power give large firms a substantial edge over small ones. Its ability to control a large fraction of agricultural supply, and most international trade, allows agribusiness to influence domestic and international prices to its own advantage, and to appropriate the bulk of government subsidies to agriculture, which take largely the form of price support for food crops (9).

While soaring prices of land also favor agribusiness, they play a complex role in the economy, as land is not produced (unlike other production factors) and its price bears little relationship to its productive use (11, pp. 74-78). In the last decade, the price of land has tripled while the price of farm products has doubled (9). Hence land serves not only as a productive factor, but also (like gold) as an alternative to other productive investments of capital, and a shelter against inflation and stagnation. Such a use of land is pushed by developers, and it only rewards those farmers who turn into developers or—sometimes—those who are forced or enticed to sell their land. Antitrust legislation is rarely used against developers who control local areas, because land control is often weighted on a national basis (as though land could be moved around) and is generally not classified according to its use. Only a few states, such as California, Delaware, and Maine, have recently enacted legislation directed at controlling land use (12, pp. 78-96).

The social structure of U.S. agriculture, unlike its technical structure, has retained many peculiar and traditional features that still distinguish it from other sectors.

[3] "Off-farm earnings have become an important source of supplementary income for farm households, especially in the highly industrialized OECD countries. In a few countries, the amount of such earnings exceeds total income obtained from farming activities proper. Off-farm employment has, however, often not been available where and when most needed" (Organization for Economic Cooperation and Development, *Review of Agricultural Policies*, Paris, 1975, p. 41).

A largely unstable and unorganized, although quite skilled, labor force is offered low salaries, hard working conditions, and the fading opportunity to become a tenant or a farmer. The industry is still largely fragmented in small units, while many of the large ones–including 90 percent of the corporate farms–remain controlled by families or partnerships, as was the case with all U.S. industries at the turn of the century. Furthermore, by general industry standards, most agribusiness (when only its farming activity is considered) is relatively small. Increasing concentration is looked upon as inevitable and beneficial (in terms of higher yields and lower prices) by most government economists (13, p. 66). Given the traditional opposition of farmers, the physical constraints of the soil, the questionable rationality (and diminishing returns) of large-scale technological investments, and the modern tendency of industry to concentrate management and finances (diversification) rather than production, further concentration of U.S. agriculture may be slow and uncertain. The benefits of rationalization, historically associated with concentration in manufacturing, are yet to come to workers in agriculture.

Injury risks in manufacturing are related to firm size. Workers' accident rates are highest (about three times a given industry average) in firms with 20 to 100 employees and decline steadily with increasing firm size, so that they fall well below the industry average in firms with more than 1,000 employees. Reported rates are probably less reliable in the smallest firms, but they also appear to decline, possibly because the owner is also a worker and knows the job and his employees. Nothing is known of work-related diseases and environmental hazards as a function of firm size. In the latter case, however, small employers are likely to be as ill-informed as their employees (14, p. 368). All agricultural firms would probably classify for their size within the highest risk or the uncertain risk category of firms for workers.

In conclusion, two agricultures appear to coexist in the U.S. and–in widely different proportions–all over the world. One is capital-intensive agribusiness. It controls the international market, which includes the domestic market of more developed countries and "plantations" in less developed countries. The other is labor-intensive family farming, which includes a small fraction of agriculture in more developed countries and the bulk of it in less developed ones. U.S. agribusiness exploits largely immigrant, nonwhite (sometimes illegal) labor; family farms exploit largely unpaid (often women's) labor and survive through "second jobs." The technical and social advantages of further industrial concentration in agriculture, as practiced in the U.S. and elsewhere, are questionable. Rational control of land use may be essential to deal with economic and social problems in agriculture.

SAFETY AND HEALTH PROBLEMS ON THE FARM

Since farmworkers seem especially hard to count (see legend to Table 3), their morbidity and mortality rates, let alone the specifics of their diseases or deaths, are little known. The few available estimates either lump all farmers, unpaid helpers, and hired workers together (1978 data in Table 5) or are restricted to hired workers in farms with more than 10 employees (1973-1977 data). Even such crude breakdowns have been available only for a few years, since 1971 when the newly instituted Occupational Safety and Health Agency (OSHA) required the Bureau of Labor

Table 5

Occupational accidents reported in the U.S.[a]

Occupational sector	1978				1973	1977
	Deaths[b]		Disabling Injuries[b]		All Injuries (adjusted rate[d])	
	Number	Rate[c]	Number	Rate[d]		
Trade	1,300	6	400,000	18	8.6	7.7
Service	1,700	7	360,000	15	6.2	5.5
Manufacturing	1,800	9	490,000	24	15.3	13.1
Government	1,700	11	310,000	20	N.A.	
Transport and utilities	1,500	29	170,000	33	10.3	9.7
Agriculture[e]	1,900	54	190,000	54	11.6	11.5
Construction	2,600	57	240,000	53	19.8	15.5
Mining	500	63	40,000	50	12.8	10.9
Total	13,000	14	2,200,000	32		

[a] Source, *Statistical Abstract of the U.S.*
[b] Figures rounded off to nearest hundred.
[c] Per 100,000 workers.
[d] 1978 rates are per 1000 workers, according to the National Safety Council. 1973-1977 rates are per 100 worker-equivalents (200,000 work-hours), according to the Labor Department. 1978 rates have been calculated on the basis of 3.5 million farmworkers. 1973-1977 rates have been calculated on the basis of 1.4 million farmworker-equivalents.

Labor Statistics to start surveying farmworkers. It should be noted that agriculture has been included in labor surveys only for statistical purposes. In 1973, in only 28 states and in Puerto Rico were farmworkers entitled to any workers' compensation and in only 16 was their coverage comparable to that of other workers. In no states were farmworkers covered by unemployment, and in only a few did they qualify for disability insurance (14, p. 522).

Farmworkers as a whole, representing less than 4 percent of the labor force, account for almost 15 percent of the deaths and 7 percent of the disabling injuries among American workers. Their death rate is inferior only to that of construction workers and miners; their injury rate is the highest in all industry. These figures, however, are certainly underestimated. Underemployment in the farm is such that about half the farmworkers included in labor surveys have worked less than 75 days a year (see Table 3). Furthermore, accidents—if not deaths—are likely to be severely underestimated among nonwhite immigrants (especially if illegal) and migrant workers: more than one-quarter of hired farm labor. Farmworkers are said to be aloof and reluctant to seek help, but they are more often victims of social discrimination; they are given less protection under the law than other workers and they are less organized. It is perhaps not a coincidence that in California, where the United Farmworkers Union (UFW) has largely based its organizing efforts on health and safety issues, there is better information about—and protection of—farmworkers.

The United Farmworkers Union has written very specific clauses in its contracts concerning the hazards of a number of pesticides (e.g., see ref. 14, p. 531).

An epidemiological study conducted in California (15) between 1959 and 1961 on differential mortality according to prevalent life-time occupation has shown that farmers and tenants suffer a high death rate from malignant skin and liver cancer, from other chronic respiratory and gastrointestinal diseases, and especially from machine accidents. Hired farmworkers live on the average 12 years less than farmers, and die as often as farmers of cancer, more often of tuberculosis and pneumonia, and much more often of motor vehicle and other machine accidents. Small farmers, included in the former group, may be at the better end of a bad occupational spectrum, of which migrant farmworkers occupy the worse end. According to testimony presented to Congress (16) and mentioned in the National Institute of Occupational Safety and Health (NIOSH) symposium on occupational health (17), migrant farmworkers' families suffer a 125 percent higher infant and maternal mortality and a 200 percent higher morbidity for influenza and pneumonia than the U.S. average.

Accidents are unanimously considered at present the worst worldwide cause of death and disability (mutilations) for workers in the farm, including women and children (18, p. 17). In the Third World, a slipping hand tool may still be a major cause of injury. Thus the International Labor Organization's 1966 report on plantations mentions a newly designed machete as a substantial contribution to the safety of workers in the banana fields of a Central American nation (19, p. 121). The same report describes the advances of mechanization in world agriculture and its consequences for plantation workers. The experience of migrant farmworkers coming into the U.S. through the Mexican border has been compared with that of workers in the early industrial sweatshops of 19th-century England (17). In the words of L. W. Knapp, of the University of Iowa (14, p. 526):

> Such machines as agriculture has needed to maintain its productivity are usually designed to grasp, pull, cut, pound, or shake agricultural products . . . and as they are not selective in dealing with living protoplasm, one can expect that corn stalks or fingers, logs or legs, feed or feet, will be treated similarly.

Two hundred and forty-six fatal farm accidents occurred in Wisconsin between 1968 and 1970, and 145 in New York State between 1967 and 1971; 39 percent of the former and more than half of the latter involved tractors. To remedy this situation, in 1975 OSHA issued a standard requiring roll-over protective structures for tractors. Unfortunately, the results of introducing these devices, which are mandatory for new tractors, may take some time to show up. First, only about 10 percent of the approximately 3 million U.S. tractors are replaced each year; second, this standard obviously does not apply to unpaid family workers or self-employed farmers. Furthermore, the notoriously weak enforcement capacity of OSHA is still weaker on the farm. Farmers are not only hard to reach by inspectors but overwhelmingly (98 percent) classified as "small business"; thus they are largely exempted from OSHA control by strong public and Congressional support.[4]

[4] Firms with fewer than 10 employees have been exempted by Congress from keeping records of accidents and diseases. In addition, agricultural firms with under 10 employees (unless they hire migrant labor) are also exempted from OSHA inspections, as all Congressional appropriations contain a stipulation to this effect (Scott Lilly, HR Congressional Office, personal communication, 1980).

Traditional problems due to exposure to severe climatic conditions, stress and fatigue, and vectors of parasitic, bacterial, and viral diseases still affect farmworkers all over the world. While industrialization, if coupled with social and economic improvements, may be expected to alleviate dramatically such conditions, it has also brought new chemical exposures. Since 1950, use of pesticides has been growing faster than most agricultural inputs in the U.S. (see Table 4) and the world (see Table 2), and has become as widespread as use of agricultural machinery. As the effects of these chemicals are (unlike mechanical accidents) often insidious and generally cumulative and far-reaching, they are usually considered the second world-wide hazard for farmworkers and their families (18, pp. 121-122).

Occupational health data are much harder to obtain than accident statistics and tend to underestimate risks because of the prevalent disregard of occupational diseases by physicians and industry's reticence in admitting their existence. Detection of chemical hazards, however, is sometimes forced upon the attention of physicians by their victims and by repeated occurrences of the same illness. The California Department of Food and Agriculture reported 28 multiple-case systemic poisonings due to organophosphate insecticides between 1949 and 1976 (20). Two-thirds of the cases were due to Parathion and occurred in citrous plantations. The clustering of the cases is such that the median number of cases reported per incident is 9, whereas the average is 27, which leads to the inference that the true incidence of systemic poisoning (other illnesses are not considered in this report) due to pesticides among Californian farmworkers must have been at least three times higher than reported (21). Another striking feature of these occurrences is the extremely high risk involved with exposure: more than two-thirds of the workers presumably exposed were taken ill. It may be inferred that extremely high exposure was prompted by ignorance or greed (or both) on the part of the employers.

The most accurate data concerning pesticide poisoning come from California, where the state covers farmworkers under its Workers' Compensation law and requires physicians to report pesticide poisoning when applying for reimbursement. Illnesses (involving treatment) due to pesticides in California among selected categories of workers are summarized in Table 6. Only the first category (manufacturers and formulators) is covered by OSHA, while other heavily exposed categories, such as applicators and mixers, are assumed to be only exposed, like the rest of the farmworkers, to pesticide residues or drifts, and are under the Environmental Protection Agency's (EPA) jurisdiction. The highly advanced industrialization of California's agriculture is reflected in several specific categories of occupational exposure. Risks appeared to decline for applicators between 1973 and 1977, presumably due to improved awareness and practices. This is not the case for manufacturers/formulators (a single plant incident involving sterility-causing DBCP affected 25 workers in 1977), or for mixers/loaders and for workers in the field (a single organophosphate incident affected 118 grape pickers in 1976). About half the occupational illnesses reported are systemic poisonings, involving neurological symptoms that may escalate to coma and death. These are often caused by organophosphates. Topical illnesses mostly involving skin and eyes, which are more frequent and severe among field workers (who cannot wear protective garments), account for the rest (22).

Even though the technical and social division of labor has subdivided their risks

Table 6

Acute illnesses due to pesticides reported in California, by occupation, 1973-1977[a]

Occupational Category	No. Cases Requiring Medical Assistance				
	1973	1974	1975	1976	1977
Manufacturers and formulators	63	71	56	42	62
Mixers and loaders	165	141	143	122	143
Air applicators and flaggers	34	23	23	22	22
Group applicators	424	225	264	246	93
Field workers	157	112	167	156	184
Gardeners and greenhouse workers					229
Warehousers and truckloaders					65
Other occupations					
in manufacturing[b]					52
in agriculture[c]					177
in services[d]					230
All occupations[e]					1,518

[a]Source, California Department of Food and Agriculture, *Annual Report*, 1979.
[b]Includes construction.
[c]Includes tractor drivers.
[d]Includes forestry.
[e]Includes 111 cases for which occupation was not available.

according to various categories, two-thirds of the acute occupational illnesses in California due to pesticides are suffered by workers directly employed in the agricultural sector. Chronic risks, presumably due to lower, repeated exposure, are poorly known outside of experimental (animal) data. However, a survey of 260 farmworkers in two Chicano communities in Texas has revealed that 37 percent suffered persistent dermatitis and 40 percent chronic headaches with other neurological symptoms (23).

As agricultural—as well as service—workers are mostly exposed to pesticide residues, their risks are indicative of potential public exposure. Farmworkers' families are exposed to residues on equipment, garments, and containers; children are exposed by working or playing in the fields. The risk for children is particularly threatening both because of their susceptibility and because of their greater exposure due to their short stature and their eating and dressing habits (24). A long, bitter controversy between U.S. farmworkers and their employers has revealed the failure of the Department of Labor (DOL), under the current laws, to protect child labor in the farm. After prohibiting child labor (under age 12) in 1974, Congress authorized DOL in 1977 to allow exceptions, upon demand, for certain agricultural employments such as hand harvesting of short-season crops. EPA's regulations and grower's information (and good will) were deemed insufficient to protect children from pesticide hazards. Therefore, to regulate the authorized exceptions, DOL issued a list of chemicals and procedures expected to be safe for children. This list was amended twice between 1978 and 1979 under pressure from growers who wished to spray other, unlisted chemicals and to employ children in the harvesting seasons. DOL regulations, however, were challenged by the National Association of Farmworkers Organization and were

invalidated in 1980 by the U.S. Court of Appeals as incompatible with DOL's duty under the Fair Labor Standards Act (25).

The issue of child labor in the farm is still unsettled in the U.S., where the Department of Agriculture has estimated that 800,000 children under age 16 work in the fields (17). Pesticide hazards for farmworkers, their families, and children must be staggering in less developed countries, where hundreds of millions of peasants work and live in the fields.

In conclusion, the changing structure of agriculture and its rapid but uneven process of industrialization involves: (a) potential alleviation of historic strains and hazards associated with farming; (b) a general lack of information concerning new hazards, especially chronic health risks; (c) an upsurge of industrial accidents in U.S. agriculture to a rate higher than in any other industry; (d) a growing exposure of farmworkers to chemical hazards that are less controlled than in any other industry; (e) abuse of pesticides, which has probably become the leading cause of occupational disease among farmworkers, due to a lack of information, legal protection, and–presumably–workers' organization; and (f) a social and international division of labor that implies an unequal division of risk.

THE PESTICIDE PROBLEM

The use of some sort of device to protect crops in the field and after harvesting against insects, rodents, and fungi (which are also a nuisance and a vector of disease), and to reduce the strain on farm labor and increase yields by controlling weeds, is probably as old as agriculture itself.

What is new in industrial agriculture is the systematic, massive use of poisons (weedkillers and defoliants) that are specifically designed not only to preserve crops from waste and disease, but also to replace human labor. Traditional practices, including crop rotation and occasional use of poisons such as heavy metals and botanic extracts, have been all but replaced by the practice of "spraying by the calendar" with synthetic organic pesticides. The new poisons are often more toxic, and generally more penetrating and persistent, than the traditional ones, hence they involve higher social (health and environmental) costs per unit. Their current use is required by the practice of stable monocultures–an ideal terrain for pests–which in turn is determined not so much by economies of scale as by the political purpose of agribusiness to control agricultural labor, production, and trade through the plantation system. It is enhanced by commercial (often cosmetic) requirements for crop quality and uniformity. Thus, although historically linked with the industrialization of agriculture, current pesticide use is often unnecessary, wasteful, and harmful.

Between 1950 and 1973, U.S. production of pesticides soared from less than 200,000 to about one million pounds. One billion dollars worth of pesticides (51 percent herbicides and 30 percent insecticides) was sold in 1970, of which 95 percent were organic chemicals. Twelve percent of the total sales went to exports; 61 percent of the domestic sales went to farmers, 19 percent to institutional (including forestry) users, and 19 percent to residential users (26). Sales almost doubled between 1970 and 1973, after which year the U.S. pesticide industry stopped publishing data on its production (9). U.S. production is said to have peaked in the mid-1970s, possibly

because of increasing domestic and international pressure against pesticide abuse. Total imports of pesticides in less developed countries, however, tripled between 1972 and 1977, reaching $938 million (3). Their destination is selective. Nicaragua, for example, imported about $10 million in pesticides per year between 1965 and 1971, of which 80 percent was sprayed on cotton plantations that yielded an estimated $55 million per year of exports (6, p. 288) to the Somoza family and its business partners. Use of herbicides is about twice as high as combined use of insecticides and fungicides in the U.S., but only half as high in the rest of world (6, p. 212). The latter pattern is presumably heightened in the Third World wherever cash-crops especially valuable for export need to be preserved, while farm labor is still abundant and cheap.

But human life may be cheap, too. The World Health Organization estimated in 1973 a global figure of 500,000 cases of pesticide poisoning per year, with a one percent fatality rate (27, p. 89). A Department of Health, Education, and Welfare officer in 1972 guessed 800 fatalities and 80,000 poisonings in the U.S. (16). Reliable data are scarce. Seven hundred and sixty-four fatal poisonings were reported in Japan in 1960, of which many may have been suicides (18, p. 147). Excluding suicides (258) and homicides (3-12), 60 fatal pesticide accidents (killing 12 workers, 24 other adults and 24 children) were reported in California between 1965 and 1975—an average of less than 6 per year (22). By contrast, 150 accidental fatalities—or almost 19 per year—were reported in Florida, another farming state, between 1965 and 1972, and 30 in El Salvador in 1972 alone (6, pp. 233-235).

Non-fatal poisonings are very rarely the result of suicide (or homicide) attempts and disproportionately affect farmworkers and children. Some 6,500 cases were reported among children under age five in the U.S. in 1975, and the figure is increasing (28). The number of cases (mostly farmworkers and their families) reported from the cotton region of Central America is affected by gross statistical inaccuracies, which in turn reflect the prevalent lack of concern for farmworkers' safety and health. However, between 1965 and 1972, 474 to 2,787 accidental poisonings per year were reported in El Salvador (where health statistics used to be accurate), 659 to 1,374 in Guatemala, and 258 to 356 in Nicaragua. The true number of cases would most likely reveal a reverse pattern, as pesticide use is comparable in the three nations, but reports from Nicaragua and Guatemala mention wildly indiscriminate use, widespread contamination of food and water, and intoxication of thousands (6, p. 255; 19, p. 209; 29).

To be effective against their target, all pesticides must be somewhat persistent, highly toxic, and able to penetrate through the body envelopes of living organisms, including human skin. Additional exposure routes are lesions of the skin (frequent in manual workers) and inhalation or accidental ingestion of residues. Human exposures and most common pathologies in the U.S. are summarized in Figure 2.

Extreme human toxicity is due in some cases to minute impurities contained in many commercial preparations, e.g. dioxin, which is found in chlorophenolic defoliants and in solvents and elicited the EPA in 1979 to propose the ban of 2,4,5-T, a herbicide widely used by the U.S. government in Vietnam and over domestic forests (30, 31). Toxicity may also be due to not-so-minute impurities in the solvents themselves. They commonly include at least 1 or 2 percent toxic benzene, known to cause

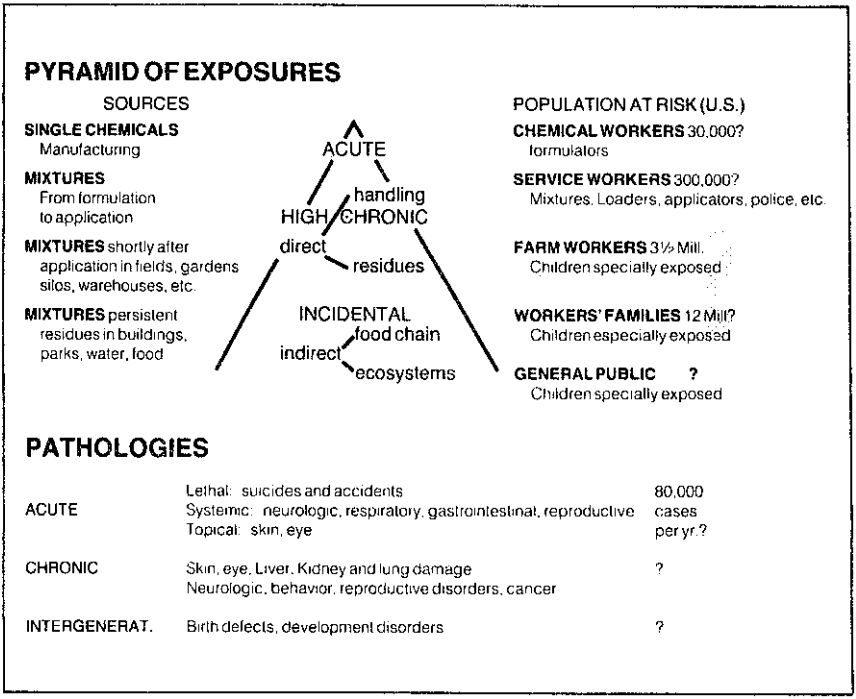

Figure 2. Pesticide exposure and risks in the U.S.

acute and chronic respiratory, heart, and blood diseases, including leukemia. All active ingredients of pesticides, however, are more or less toxic to humans and to other animals.

High acute neurotoxicity is a major problem with most organophosphates (including Parathion) and, to a lesser extent, with carbamates. Both interfere (with varying speed and reversibility) with neural transmission of all animals. Neurotoxicity also occurs with some organochlorines, such as Kepone. As organophosphates and carbamates have a relatively short half-life in the fields (a few weeks), it is important to establish a safe re-entry time after each chemical is sprayed. The problem is complicated, however, by the number of different chemicals used, by geophysical and meteorological circumstances variably affecting the half-life of each chemical, and by the fact that physiological conditions (e.g. age, sex, nutritional state) affect the susceptibility of those exposed (21, 24, 32).

Organochlorines (which include DDT) are generally less acutely toxic to humans than organophosphates, but their half-life in the soil may be as long as thirty years (33). DDT accumulates in fat tissue (including human brain and milk), and its extensive use has proven destructive to earthworms, birds, and fish, including many pest-predators. Meanwhile, DDT-resistant insects are selected. The number of species of public health importance resistant to DDT or Dieldrin (another organochlorine) was found by WHO to increase from 27 in 1956 to 91 in 1974 (6, p. 219). While DDT

has contributed dramatically (albeit temporarily) to reducing the toll of malaria and other diseases and (more questionably) to sustaining intensive farming, its abuse has all but defeated the purposes for which it was developed in the first place. Its present use is restricted in most countries to home spraying for hygienic reasons (6, pp. 220-225).

Chronic hazards are harder to prove, as they require long-term epidemiological studies and experimental evidence in animals. Some chronic risks of pesticides appear as predictable extensions of acute ones, including behavioral and neurophysical disorders linked to chronic exposure, intestinal, liver, and kidney damage associated with xenobiotic poison metabolism, and skin cancer linked to chronic chemical irritants. Of 193 pesticides tested, 23 were found to be mutagenic in bacteria and a few more in *Drosophila* (34). Of 113 pesticides reviewed by NIOSH, 26 were considered suspected occupational carcinogens and data for another 27 were found inconclusive (24).

Reproductive effects of pesticides include mutations other than those affecting somatic adult cells (which are linked to cancer), decreased ability to generate (including infertility), damage to the fetus during pregnancy (resulting in illnesses and malformations), and damage to infant and child development (as, for example, through breast milk). Epidemiological and experimental studies are difficult and costly. Eight pesticides have been shown and three more are suspected to cause birth defects in animals. These include chemicals which are widely used, such as several organochlorines and, possibly, Parathion (24). Rates of menstrual dysfunctions and spontaneous abortions (evidence of fetal damage) were found to be correlated with pesticide exposure among 652 women followed for 15 years by the National Institute of Neurological and Communicative Disorders (24). Increased frequency of birth defects was reported in farmworker families exposed to pesticides (35). Widespread sterility was detected in 1977 among 107 male workers involved with the manufacture or formulation of DBCP, a nematocide that had been classified as a "mild irritant" fifteen years earlier (36). Peach growers have implied that those who handle pesticides causing sterility are often Catholic farmworkers who do not want children (37).

Such an artful way of blaming the victims of pesticide reproductive hazards was elicited by a long dispute over emergency re-entry time standards, issued by OSHA in 1973 under pressure from migrant farmworkers and challenged by Florida growers. Such standards were never enforced, as the U.S. Court of Appeals found "no substantial evidence of grave danger," (38)

While workers may learn from experience how to deal with, or avoid, certain hazards, this can hardly apply to chronic and certainly not to long-term ones. In any case, not only is such a learning process unfair to workers, on whose bodies it takes place, but it is also slow and inefficient, particularly with those who have lesser experience with the hazards, including workers' families and the general public. Furthermore, the "body count" is bound to start anew, as soon as a new formula or procedure is introduced by the chemical or the agricultural industry.

In conclusion:

- Pesticides are used for sanitation and for technical-economic purposes, to preserve crops and to save labor.

- Current industrial practices involve massive, indiscriminate, often unnecessary use of many synthetic organic pesticides.
- All these are general poisons (with diverse chemistry and toxicology) that must be persistent and able to penetrate through body envelopes.
- Their hazards affect workers, workers' families, and the general public, in order of decreasing exposure but increasing population at risk.
- Pesticides can cause acute, chronic, and intergenerational health damage, including neurological and skin diseases, cancer, and probably birth defects; and environmental damage, affecting the food chain and the human use of ecosystems.
- Pesticides pose a high risk for children, and a very high risk for peasants in less developed countries.

PESTICIDE REGULATION

Growing concern for the health and environmental effects of pesticide use and abuse has prodded the United Nations and many governments to sponsor studies, issue guidelines, and enact laws to regulate their production, use, and disposal. The present regulatory framework in the U.S. is summarized in Table 7. It has been brought into existence by four major interest groups (39) in changing historical relationship to each other and to the nation's economic policy:

1. Farmers were originally concerned largely with obtaining reliable information—including labels—on pesticide effectiveness and uses (Federal Insecticide Act of 1910).
2. The general consuming public became concerned with pesticide residue in food and homes (Federal Drugs and Cosmetic Act of 1938, FeDCA; Federal Insecticides, Fungicide and Rodenticide Act of 1947, FIFRA), which led to requiring the U.S. Department of Agriculture to set tolerance limits.
3. The environmental movement, at first largely intellectual and middle-class in character, raised and organized public concern into a philosophical and life-style framework. This prompted the environmental laws of the 1960s ("Clean Air," "Clean Water," and the National Environmental Protection Act of 1969) and promoted the establishment of EPA, the first government agency with regulatory power (that is, some legislative and judicial authority) over environmental safety and health.
4. Finally, the trade union movement entered the legal environmental scene with the Occupational Safety and Health Act of 1970 (OSHAct), designed to regulate the working environment. Growing concern on the part of workers and environmentalists for less obvious chemical hazards pushed through Congress the Toxic Substances Control Act of 1976 (ToSCA), which was said by *The Business Lawyer* (40) to "convert the chemical industry into a regulated industry."

The 1972 and 1978 amendments to FIFRA (substantially rewriting the pesticide legislation) and the 1978 amendment to the Consumer Products Safety Act (CoPSA) also emerged from the joint concern of labor and environmentalists. According to a *Business Week* editorial (41), as a result of suits by consumers and workers for damages attributed to hazardous chemicals or equipment, "the costs of product liability suits are becoming a horrendous problem for U.S. industry." While statutory law (such as the acts mentioned above) determines the scope and limits of regulation,

Table 7

The regulatory framework for pesticides in the U.S.[a]

Regulated activity	Agency	Authority[b]	Means
Design of alternatives	USDA	FIFRA	Field tests, research grants
Production of new chemicals, new uses of old chemicals	EPA	FIFRA, ToSCA	Requirement of information and tests, experimental use permit, registration
Production of old chemicals; processes and work in plants	EPA, OSHA	FIFRA, ToSCA, OSHAct	Requirement of information, exposure, and performance standards; labels; cancellation; suspension; monitoring
Sales			
Domestic	CPSC[c]	CPSA, ToSCA	Restriction of sales, ban
Export	State Dept.	Executive	Notification
Exposure to residues, including work in farm	EPA	FIFRA	Labels, exposure standards (re-entry time), monitoring, suspension
Compensation			
At work	SWCB[d]	State law	Mandatory insurance or suits
Other	–	Common law	Private insurance, suits
Agency decisions and activities	–	Agency's statute, common law	Suits, administrative action

[a] Source, reference 39.
[b] The law that defines the scope and limits of regulation, from which agencies derive their authority. For abbreviations, see text.
[c] Consumer Products Safety Commission.
[d] State Workers Compensation Boards.

common law and citizens' suits represent its necessary back-up, which also points out gaps and weaknesses in the legislation and in the activity of regulatory agencies. On the other hand, such activities are continuously challenged, and often stalled, by industry suits.

It took ten years for OSHA to conclude only five rule-making proceedings in the health area following enactment of the OSHAct of 1970,[5] all against the stiff opposition and delaying tactics of industry representatives. Each case requires, first, a long preparation by the agency (involving scientfic research and public hearings) and then,

[5] These are the asbestos standard (1972), the carcinogen standard (covering 14 substances, 1974), the vinyl chloride standard (1974), the coke oven emission standard (1976), and the lead standard (1978). By contrast, "In November 1977, the registry of chemicals maintained by the American Chemical Society listed 4,039,907 compounds. . . . The list has been growing at a rate of 6,000 per week. The number of chemicals currently in commercial production in the U.S. may be as high as 70,000 . . . and the business is worth $113 billion per year, about 7 percent of the nation's GNP" (Council of Environmental Quality, *Report 1978*, p. 178).

an extenuating legal battle concerning the experimental and epidemiological evidence, the need for the proposed rule, and its technical and economic feasibility. These standards determine the maximum allowable exposure (which in some cases is considered too high by many) to the well-known hazards of a few toxic substances such as asbestos, vinyl chloride, and lead in the factories. Litigation concerning inspections, violations, and fines takes another considerable part of the regulatory agency's energy and resources.

EPA's record is quite similar, especially since this agency has been charged by ToSCA with regulatory activity directly affecting the chemical industry. An exemplary case, concluded in 1976, involved the pesticides Heptachlor and Chlordane. Under FIFRA, the agency had suspended the registration of these substances with respect to certain uses. A challenging petition was filed before the U.S. Court of Appeals by Earl L. Butz, U.S. Secretary of Agriculture, and joined by Velsicol Chemical Company, the presticide's sole manufacturer. The petition contended that Chlordane did not pose "imminent hazard" to human health, as its carcinogenicity had been proven "only" in animals, and that the EPA made critical errors in weighing the risks against the benefits of its continued use. On the opposite side, the Environmental Defense Fund challenged the EPA's concession—among others—to continue use of the suspended pesticides until exhaustion of existing stocks. The court upheld the EPA decision against the Department of Agriculture's and Velsicol's objections and ordered the EPA to rescind its concession, for failure to consider the amount of stocks left and the problem of returning and disposing of them. The court concluded this decision with a realistic remark (42): "It may be that the lapse of time has lessened the current significance of [the stock's] issue but we are in no position other than remand for further consideration." Subsequently, Velsicol was indicted for keeping data from the EPA concerning carcinogenic effects of Heptachlore and Chlordane (43).

The economic rationale of regulation is to make firms that cause damage to workers' and public health or to the environment pay for such social costs. Rules, inspections, fines, legal expenses, and compensation for damages[6] are expected to function as a deterrent, prodding industry into compliance with established, supposedly safe, standards. Furthermore, as hidden or unaccounted social costs ("externalities") become an integral part of industry's production costs, it is hoped that safer products, processes, and practices will be promoted or discovered. Thus, the political rationale of regulation is to subordinate and attune technological progress to social progress. The physical and economic feasibility of new technology is more readily assessed by discretionary decisions of the regulatory agencies (and the courts) through public hearings. The direction and speed of social progress, however, is a political issue that probably requires improvements in the democratic process.

While the social costs of regulation are high, the costs of its failures—witness PBB in Michigan (44), the problem of toxic waste disposal, and the daily toll of occupational accidents and diseases—are staggering. Despite business outcry against its alleged excesses, regulation is still painfully inadequate to achieve its goals. In dealing with

[6]Worker compensation laws, although indispensable, do not serve the purpose of promoting a safer and healthier workplace, as they establish a sort of no-fault insurance system (14, pp. 416-421).

toxic chemicals and pesticides, the EPA has been plagued by a lack of information, resources, and political leadership. The complexity of the information required, concerning 35,000 commercial pesticides containing 500 major active ingredients (28), is compounded by manufacturers' reticence in providing data relative to the amounts used and effects observed. The secrecy of formulators (largely small businesses) is such that often no one in the farms knows precisely what kind of mixture is being sprayed. Highly toxic Parathion has been sold in brown bags to kill roaches in the ghettoes of U.S. cities (6, p. 235). Given such circumstances, a sustained struggle is required simply to collect and publicize (through mandatory labels) the existing data. Development and diffusion of information are crucial not only for the agency to reach rational and timely decisions, but also to make sure that such decisions are made democratically (under informed public control) and are in fact implemented.

The office of toxic substances and pesticides is still understaffed. As of January 1, 1979, the EPA had 12,816 employees on its nationwide payroll, as compared with 115,078 in the Department of Agriculture (whose position concerning health and the environment is exemplified by the Heptachlore/Chlordane case) and 971,978 (civilians) in the Defense Department. The number of civilian government employees increased between 1950 and 1974 from 11 to 16 percent of the U.S. labor force. In the same period, the proportion of non-production employees in manufacturing grew from 18 to 27 percent (from 28 to 42 percent in the chemical sector) (9). Thus, contrary to current allegations, resources devoted to accounting and control seem to grow exactly as fast (by 50 percent in the third quarter of this century) in U.S. private industry as in government. Such an increase likely reflects the needs of an increasingly complex, technological society. The real issue is that environmental affairs, health, and safety are generally considered by industry to be its own private business, and these areas are not given high priority as public business by the U.S. government.

The EPA's insufficient political leadership is a complex problem, involving the agency's wisdom and decisiveness in pursuing its statutory goals, as well as the limits of its mandate. The EPA was probably expected by the Nixon Administration to defuse the political potential of the environmental movement by promoting traditional values and quietly redistributing some costs and benefits of growth and development by compensating landowners. Jurisdiction over work and pesticide exposure on the farm has been the object of a simmering bureaucratic dispute between the EPA and OSHA. Growers' lobbying escalated into threatening the transfer of farmworkers from Labor to Agriculture Department jurisdiction, struck down emergency re-entry time standards issued by OSHA in 1973, and won control to the EPA over the issue in a compromise settlement one year later (14, pp. 527-528). Although the EPA had issued its own standards, it did not possess the manpower to enforce them, and not until 1977 did it establish (together with other agencies) a joint strategy to deal with toxic substances.[7]

The 1970s brought increased pressure for health and safety from labor and environmental groups (e.g. Chicanos "Colonias," the National Association of Farmworkers

[7]The 17-agency Toxic Substance Strategy Committee, the Interagency Research Liaison Group (including EPA, OSHA, the Food and Drug Administration, and the Consumer Products Safety Commission, and dealing also with enforcement policies), and the Interagency Toxic Substances Data Committee were established in 1977.

Organizations, Migrant Legal Action, and the Scientific Institute for Scientists' Information), new legislation and court decisions, and strengthened agency activity. OSHA's proposal (45) of a generic standard for carcinogens (to improve costly and slow rule-making for single chemicals) has been endorsed by the EPA and extended to pesticides' reproductive effects. The latter agency has identified for regulatory action 65 pesticide ingredients that are highly toxic or widely used and has established a procedure of "Rebuttable Presumption Against Registration" (RPAR) of new pesticides. Between 1976 and 1979, 27 RPAR notices were issued, resulting in 19 withdrawals by industry and 7 final decisions (28).

The regulatory process is shaped by the changing political climate, which is also reflected in the appointments of judges and regulators. Some options, such as workers' and citizens' access to the courts and the regulatory agencies, may be severely restricted by a conservative Presidency and Senate, and all are conditioned by the strength and determination of citizens and workers in defending their rights.

In conclusion, the regulatory process is meant to attune technological progress to society's needs and goals; and equitably distribute the present social costs of "externalities" (health and environmental hazards). It has evolved in a context adversary to industry, because of the latter's historic neglect of such "externalities." It is beginning to extend the area of democracy into the working and the living environment, but is hampered by insufficient information and resources and by political uncertainties. In terms of pesticides, the regulatory process includes: (a) the ban of the most hazardous or unnecessary products and practices; (b) specification of safe uses and procedures, such as re-entry times; (c) enforcement of restrictions and disclosures (including labels); and (d) the right to sue on the part of industry, but also on the part of citizens and workers. ("Refusal of hazardous work" cannot be cause for discrimination, as recognized by the U.S. Supreme Court[8]).

CONCLUSIONS AND PERSPECTIVES

A War That Can't Be Won?

Pesticides are powerful weapons which have been introduced for sanitation and public health purposes and have been appropriated by modern agriculture for economic purposes as part of its industrialization process. These two separate aspects of the war against pests need not coincide in their methods and objectives, unless total eradication of pests is set for both as an unambiguous, realistic goal. Species that are vectors of human diseases may be useful in agriculture or other industries, however, and even the definition of usefulness is relative to our present methods of production and our understanding of ecological systems.

[8] *Whirlpool Corporation v. Marshall. Law Week* 48: 4189, Supreme Court, February 26, 1980. Two maintenance workers refused to walk over a mesh screen suspended over a work area, where they had been ordered to retrieve material that had fallen from an overhead conveyer. Earlier, a similar order caused the fall of two fellow workers (one of whom died) when the screen gave way. The refusal brought loss of pay and a notation of blame in the workers' personnel file. Although important in principle, the Supreme Court decision only established that workers cannot be punished (or dismissed) *explicitly because of refusing hazardous work.* The pay issue was not dealt with, being beyond the authority of OSHA.

Industry's research and development have focused on economic benefits and the more easily detectable acute risks in an effort toward providing an array of chemicals with different modes of action so as to minimize the probability of resistance selection and to eradicate pests. The major obstacle on the path to total victory lies in the fact that only highly toxic concentrations of chemicals are likely to eradicate pests, thus preventing the occurrence of resistance. Such high concentrations have invariably proven toxic to other species, including pest predators and humans whose relative immunity is subject to environmental and physiological variation. Therefore, many toxicologists have reached the conclusion that the age-old war against pests is unlikely to be won once and for all by any combination of magic chemical weapons. This conclusion is similar to that reached in medicine with respect to antibiotics and other chemotherapeutic drugs (46, pp. 127-139).

Containment, rather than eradication, of pests is often a more realistic and, perhaps, a more cost-effective objective in sanitation (6, pp. 89-93). The advantage of containment is probably much stronger in agriculture, given the close relationships and interdependence of plant and animal species in the field with each other and with their environment. While it is certainly possible to win many more battles against pests through advances in biochemistry, each battle must be planned on its own field. To wage what is likely to be a protracted war and integrated pest management strategy (47; 48, p. 89) is essential. This strategy includes: (a) study of (and diffusion of relevant information on) the ecology, biology, and population genetics of pests; (b) design and development of alternative, flexible containment methods, including traditional ones (e.g. crop rotation) and new ones (e.g. biological and genetic control, feromones, and safe pesticides); (c) implementation of appropriate programs to forecast, prevent, and deal with specific pest threats, when and where they occur; and (d) institution of an effective aid and communication network to make the above information, programs, and methods available and accessible to all farmers, and to utilize their experience in designing and displaying the overall strategy.

Politically intelligent regulatory action is crucial to ensure active support for integrated pest management by agricultural agencies such as the FAO and USDA (which until recently promoted indiscriminate pesticide use); to reverse farmers' habitual dependence on (organic synthetic) chemical control of pests; to reorient the research and development efforts of government, university and industry; and to win workers' control over health and safety in agriculture and other industries.

Cost-Benefit Analysis

Analysis of risks and benefits deriving from the use of pesticides and other toxic substances is mandatory for EPA rule-making under ToSCA, FIFRA, and other statutes. Such an analysis is increasingly required by the courts to support any proposed rule that is being challenged by the affected industry, even when not mandated by law (as it is not by the OSHAct).

Cost-benefit analysis involves (49, Ch. 9): (a) identification of all impacts of a project (e.g. a proposed rule) and of the alternative options, such as doing nothing; (b) assignment of a quantitative value to each impact on the basis of discounted market prices (when possible) or of people's estimated "willingness to pay" for

obtaining a benefit or averting a risk; and (c) acceptance or rejection of the project, on the basis of its comparative cost-benefit balance, its cost-effectiveness (ratio of benefits to costs), and its redistribution benefits (that part of the total net benefit which is accrued to the group the project is supposed to help).

Even the advocates of the cost-benefit approach recognize that this analysis is only a tool—which is frequently used improperly, as it is "especially vulnerable to misapplication through carelessness, naiveté, or outright deception" (49)—and that dollar estimates are imprecise and subjective in many cases. It is a powerful tool because it provides a general model that (according to its advocates) forces decision makers to make explicit the reasons for their choice, or (according to critics) is quite suitable to justify their choice. This is probably the reason for its strong appeal to decision makers.

While properly used cost-benefit analysis is a perfectly rational and useful accounting device to optimize the economic choices involved in regulatory decisions, it disregards the political rationale of these choices: the subordination of technological to social progress. Politically acceptable and necessary regulatory decisions may involve economic costs that can neither be assessed nor paid through a fictional mechanism such as "willingness to pay." The latter depends not only on ability to pay, but also on the information available and on the social distribution of costs and benefits (who pays and who profits from regulation or the lack of it).

A Political Turning Point

Since the late 1970s, economic stagnation, increasing unemployment, and a conservative backlash have escalated industry's pressure against regulation. When *laissez faire* is not being reproposed as the general cure for economic problems, a new device is provided for a scientific balancing in terms of social costs and benefits. This approach is guaranteed to interfere as little as possible with present income distribution patterns. In either case, the classical theory of general economic equilibrium (from which cost-benefit is derived) is presented as both a theoretical model—which it is, though probably an inadequate one—and a prescriptive model: Adam Smith's "invisible hand" is reproposed as a general cure for social problems.

The OSHA proposal for a new benzene standard was defeated in 1978 in the U.S. Court of Appeals by the American Petroleum Institute, which contended (50) that the Secretary of Labor failed to show substantial evidence of risk and to consider "whether [the] benefits expected from [the] standard bear a reasonable relationship to [the] costs imposed by [the] standard." As benzene is known to cause leukemia in man but not in animals (an uncommon lack of coincidence), substantial evidence of risk presumably means a "body count," and consideration of cost-benefit may imply that the current price of human life ought to be estimated.

The Supreme Court recently upheld the Appellate Court's invalidation of the new benzene standard, in a sharply divided decision (5 to 4) which stops short of prescribing cost-benefit analysis and quantification of the risk as prerequisites for any regulatory action. According to the minority opinion (51):

> The plurality ignores the plain meaning of the Occupational Safety and Health Act of 1970 in order to bring the authority of the Secretary of Labor in line with

> the plurality's own view of proper regulatory policy. . . . The plurality's standard . . . is based only on the plurality solicitude for the welfare of the regulated industries. . . . The plurality's discussions of the record in this case is both extraordinarily arrogant and extraordinarily unfair.

The decision of the Supreme Court indicates some disfavor toward OSHA's (and the EPA's) proposed generic policy to deal with carcinogens (which was not under scrutiny) and is probably going to dwarf the agencies' efforts to curb long-term chemical hazards in the workplace and in the general environment. The decision elaborates the need to limit the excessive discretionary power that the Secretary of Labor could derive from the OSHAct, but its real target is probably labor itself. Workers' recently won right to accompany OSHA inspectors is being curtailed. The first, timid attempts to extend democracy into the workplace during the 1970s, at least concerning health and safety issues, may be perceived by the judicial branch of government as a threat to the balance of power between management and labor, institutionalized by the Taft-Hartley Act of 1947.

How far the present conservative backlash will reach may depend in part on the willingness and ability of regulatory agencies to seek and obtain the active support of all those who are victims of political, social, and economic discrimination.

Risk Pay

The notion that salaries, as a result of free-bargaining between employers and workers, include a portion (risk pay) that covers the specific risks involved in each job is no longer an accepted legal doctrine. While economic necessity is still a universal factor forcing workers to accept hazardous jobs, lack of information about risks and profound inequalities in the labor market (discrimination against females and non-whites) within nations and among nations determines a situation in which risk pay is often unnecessary.

As toxic chemicals are sold, leak, or are disposed from the factory into the general environment, their hazards affect everyone. Acceptance of such hazards is determined by the same factors—lack of information and inequality—that make workers take hazardous jobs. A form of environmental blackmail is used by U.S. business to lure communities and local governments into accepting the establishment or the continuing operation of hazardous plants, in order to increase (or maintain) tax revenues, business opportunities, and the availability of jobs (52, 53). Such a device is increasingly used against labor, especially when weakened by unemployment and where little organized, as in the South or in the farms. Furthermore, the bargaining power of workers and citizens in more developed countries, and their ability to resist blackmailing and win a healthy environment, is undercut by the lack of bargaining power of workers and citizens in less developed countries.

Not surprisingly, environmental blackmail is widely used against less developed countries, and it succeeds in exporting to these countries: (a) hazardous processes, such as asbestos, copper (with arsenic), and smelting and pesticide plants (54, 55, 56); (b) hazardous products, such as chemical-containing children's wear, drugs, and pesticides that are banned in the manufacturer's country (57), but may occasionally be reimported (57, 58); and (c) hazardous wastes, of which we learn when publicity

forces the State Department to stop shipments already contracted (59-61). In the latter case, one may say that risk is exported in its purest form.

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