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**THE ENVIRONMENTAL EFFECTS OF AGRICULTURAL PRODUCTION,  
AND RELATED MEASURES:**

**Illustrative cases from developing countries**

Report by the UNCTAD secretariat

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## **THE ENVIRONMENTAL EFFECTS OF AGRICULTURAL PRODUCTION, AND RELATED MEASURES:**

### **Illustrative cases from developing countries**

#### *1. Scope and main findings*

1. Concern about the environmental effects of agricultural production is a comparatively recent phenomenon. Even though certain traditional practices of subsistence agriculture, such as slash-and-burn farming and the absence of erosion-minimizing techniques, were recognized as ecologically detrimental, until the 1960s the general perception was that the pace and level of natural resource use were within the carrying capacity of the environment. In developing countries, tools used in clearing forests were rudimentary, the process slow and the felling selectively confined to smaller trees. Trees which were too big to cut were left standing and the ecosystem was not completely disrupted. The big trees continued to provide nutrients and shelter to the soil, while their roots minimized the risks of erosion. When the area was eventually abandoned, the presence of these trees hastened the process of reforestation.

2. In many parts of the world, agricultural production has since moved from subsistence to a commercial level of operation. Unprecedented demographic growth and urbanization, together with increased participation and dependence on international trade, have led to greater pressure to raise output from the agricultural sector. For most developing countries, increased agricultural output has been important not only to supply the domestic market but also to meet the ever-expanding foreign exchange needs and serve as the engine of growth for attaining economic take-off. Efforts have focussed on increasing yields in order to fulfil domestic food self-sufficiency programmes and to expand export capacity. Forests and other wildlands were rapidly cleared to extend agricultural land; agriculture became more intensive with the introduction of practices such as multi-cropping and agrochemical applications.

3. The ecological problems increasingly experienced in agriculture and the tightening ecological standards worldwide have highlighted the pressing need for commodity-exporting countries to review the sustainability of their commodity production activities, to take stock of the state of their natural resources, and to undertake the shift towards ecologically preferable production techniques in order to ensure the sustainability of their own natural resources and their export capacity.

4. UNCTAD, with the support of the Governments of the Netherlands and Norway, undertook case studies on the environmental impacts of the production and processing of three commodities which are of vital importance to many developing countries as foreign exchange earners and/or as staple food. The

findings of these studies provided the background material for the UNCTAD report entitled "Fostering Sustainable Development in the Commodity Field: Experiences concerning environmental effects of commodity production and processing - synthesis of case studies on cocoa, coffee and rice," (TD/B/CN.1/15) prepared for submission to the Standing Committee on Commodities at its second session. The countries covered were Brazil, Cameroon, China, Costa Rica, El Salvador, Nigeria, the Philippines and Thailand.

5. The present study aims to contribute to discussions on this issue by presenting further examples of linkages between commodity production and the state of the environment. It is based on published information, reports in the press, and the responses to letters addressed in early 1993 to around 75 national and international agricultural research institutes throughout the world, soliciting research findings and information related to the production and processing of agricultural commodities, especially coffee, cocoa and rice. It surveys experiences in agricultural commodity production of developing countries, the environmental consequences, and action taken to correct damaging practices. The discussion is organized according to the sources of environmental effect, as follows: (a) how specific agricultural practices impact on the environment; (b) how other sectors affect the agriculture-environment linkages; and (c) how government policies and programmes influence these links.

6. Because of the relative novelty of environmental impact assessments in developing countries, quantitative data on agricultural production are extremely limited and information tends to centre on a few countries. Some of these countries have already been covered by the case studies; findings from other sources are nevertheless included to supplement or to reinforce earlier conclusions.

7. Given the numerous factors which affect both the agricultural sector and the environment, and the degree and complexity of the interrelationship between and among these factors, no one factor can be isolated or attributed as a direct cause of a specific effect. The examples cited in the present paper are country- or region-specific, but the problems they present are prevalent in many other developing countries and could therefore be of general use in formulating sustainable agricultural development policies. They also serve to highlight the fact that the link between agricultural commodity production and the environment is multi-dimensional and multi-directional. For instance, a single farmer's decision on how to prevent or combat pest attacks in terms of methods to be used, effectiveness and intensity of the product chosen, frequency and timing of application, the period over which the same method was applied, as well as the use of measures to protect other vegetation and the surrounding areas in general, determine the degree of crop protection not only for his own but also for the surrounding farms, not only for the present harvest but also for future ones, and not only for a specific crop but for other plants as well. His decision also has a bearing on common resources, including critical elements such as water supply and air quality.

8. The environmental consequences of agricultural production techniques spill over to other sectors of the economy as well and influence the overall economic well-being of the country. The degree of "cleanliness" and sustainability of the agricultural commodity production, for instance, determines the quality and continuity of the supply of raw materials needed to feed industry. Additionally, the socioeconomic costs of environmental degradation at the farm level are high: mass rural-urban migration of families forced to abandon farms which have ceased to be productive aggravates urban problems, such as rampant unemploy-

ment and housing congestion, prevalent in developing countries today; health problems arising from the contamination of drinking water sources result not only in increased medical costs but also in reduced work-days; death and illness from agrochemical exposure among farm workers represents a loss not only to their immediate families but also to society at large.

9. On the other hand, the farmer's decision-making process and mode of operation are restricted by a host of factors. Foremost among these are limited access to agricultural extension assistance, on the one hand, and the aggressive marketing techniques of agrochemical sales agents, on the other; lack of cash reserves to invest in making anti-erosion structures; absence of market intelligence which hinders him from making timely and appropriate crop switches. Often farmers might also have to operate under environmental conditions determined by activities in non-agricultural sectors, as for example in cases of environmental spills from industries and urbanization, heavy sedimentation owing to large-scale upland forest clearance, or salinization of water resources caused by depletion of the water table.

10. The complex relationship between agriculture and the environment and, through their ecological consequences, the link between agriculture and other sectors of the economy, are being increasingly acknowledged and addressed at both the national and international levels. Most agriculture extension programmes now include training on how to detect signs of environmental stress. Elements of sustainable farming, such as crop mixing and integrated pest management, are gradually being integrated while agrochemical subsidies are phased out. At the international level, agencies such as FAO and IFAD have included sustainability as an important element of their assistance programmes and inter-governmental organizations and national donor entities including the World Bank and the Swedish International Development Agency (SIDA) demand an environmental impact assessment as a prerequisite to project financing.

11. The examples cited in this paper indicate that the environmental issue, at least for the agricultural sector, is manageable if appropriate policies are adopted and implemented effectively. In view of the critical links between agricultural sustainability and economic development, the question facing commodity-producing countries is not so much whether sustainable agriculture is preferable or not, but rather whether it is affordable or not. Nevertheless, examples abound (*see Annex*) of farming techniques which are both productively viable and ecologically beneficial. They do not require heavy capital outlay in terms of machinery and structural investments and do not need high intensity training and special skills. Switching from conventional agriculture to ecologically-friendly farming, however, implies a temporary loss of farm income to cover the time gap needed to restore soil fertility.

12. It takes an estimated minimum of three years to rehabilitate the soil from the harmful effects of chemical-based farming. Cooperation on both the national and international levels is critical during these initial years: farmers need technical assistance and a subsidy from the government; developing countries, in turn, require the support of the international community in making this transition. Permanent measures will also have to be taken at the international level to sustain ecologically-friendly production techniques. Among these are the internalization of environmental costs into commodity prices and improvements in production methodology. Increasing public awareness of the environmental issues and changing consumer preferences for ecologically-produced commodities augur well for the successful implementation of environmental protection measures.

## ***II. Agricultural practices and their environmental impact***

13. Many modern farming techniques have serious adverse effects on natural resources in terms of soil depletion, water contamination and air pollution as well as in the diminution of flora and fauna diversity. Nevertheless, certain practices in current use are also beneficial for the environment. They have been either recently developed<sup>1</sup> or revived from ancient practices, and have been adopted essentially on the basis of their effectiveness in increasing productivity and yields and in cutting production costs.

14. This section presents examples of agricultural practices which are both productive and ecologically viable. It is important to point out, however, that here is a growing array of environmentally sound agricultural practices, and the choice as well as adoption of any one option is a complex matter involving numerous technical as well as policy issues. The replication of positive experiences may therefore not be a simply and easy task.

### ***A. Land utilization***

15. Nomadic cultural practices, rapid population growth, and marginalization of small-scale farmers contribute to the "tragedy of the commons." It manifests itself in the persistence of slash-and-burn agriculture in certain developing countries and in the conversion of areas considered ecologically fragile into farmlands. In respect of the latter, the breakdown of traditional land tenure systems is also an important factor. The encroachment on common lands is intensified through loss of farm productivity owing to irreparable damage of soil caused by unsustainable farming techniques. Many governments which, at times, had encouraged conversion of forests and other common lands into farmlands have now undertaken programmes to control wilderness encroachment by promoting the practice of sedentary agriculture and by enacting legislative measures to ensure the sustainable use and protection of forests and other wild areas.

16. Improved management of lands currently being farmed, in line with measures to conserve soil integrity, is one of the measures to minimize forest encroachment. In Bangladesh, for example, policies aimed at obtaining higher production from a given agricultural area were intended to limit deforestation. During the five-year period between 1986 and 1991, areas where single cropping was practised had diminished by 25 per cent while areas of double cropping increased by 5 per cent and triple-cropping by 27 per cent.<sup>2</sup> The level of rice production was maintained through the use of improved rice varieties. Production costs were actually reduced through the introduction of nitrogen-fixing paddy vegetation and cutbacks in agrochemical inputs. This contributed to maintaining the forest area in Bangladesh at about 2 million hectares while area of fallow land had almost tripled in the five-year period leading up to 1993.

17. Forest clearance and mangrove reclamation for agriculture could be minimized by relying instead on certain areas where the soil quality had been considered so poor as to be unfit for farming. For example, savannah land has such acid soils that they were once considered worthless for farming. However, with new techniques of disease-resistant breeding, chemical soil treatment, use of organic matter and no-till farming, 23 million hectares of *cerrado*<sup>3</sup> are now producing a fourth of Brazil's rice, corn and soybeans, a fifth of its coffee and 15 per cent of its beans. Environmentalists claim that farming Brazil's seemingly infinite *cerrado* could mean protecting the Amazon basin and its tropical rain forests.

18. Savannahs in Colombia have also come into farming use in recent years. This has been possible because the International Centre for Tropical Agriculture (CIAT) in Colombia has developed a rice variety which can thrive on savannah soils;<sup>4</sup> its use could also have implications for other agricultural activities and natural resource management. The Centre's researchers believe that the savannahs can sustain rice-pasture farming and that crops can be grown on up to 240 million hectares of savannah land, larger than the area of sub-Saharan Africa under food crops. The Centre stresses, however, that in view of the fragile condition of savannah lands, rice should not be grown continuously for more than three or four successive years after which period the land should be left solely for pasture for several years.

19. Under this system, rice is planted in rows while pasture seeds, a mixture of improved grasses and nitrogen-fixing legumes, are scattered over the area. Farmers harvest the rice after three to four months and then graze cattle on pasture. Additional benefits could be derived from the improved quality of pasture, which increased animal stockage twenty times over. That is, where previously one single cow was stocked to every 10 hectares, rice-pasture farmers are now able to stock two animals per hectare. Moreover, cattle on rice-pasture land seem to gain weight faster than those on traditional pastures, enabling farmers to market them within 15 to 16 months instead of the original 24-month waiting period.

20. Erosion or the loss of fertile topsoil to wind and rain runoff is the cause of a constant and ongoing battle between farmers and the forces of nature. While certain agricultural crops and techniques, such as the *cabruca* system used in Brazil's cocoa plantations<sup>5</sup> have been known to actually control or even arrest the loss of topsoil to wind and rain, some others only serve to accelerate the process. Among the latter is the removal of ground vegetation and shade trees in order to facilitate planting and crop maintenance, which is a prerequisite in cereal monoculture. By depriving the soil of its protective cover from strong winds and heavy rains, soil integrity is threatened not only by the continuous absorption of the same nutrients over time but also by rapid erosion through inadequate ground cover and soil anchor.

21. Even Argentina's vast and prodigiously fertile pampas have succumbed to the deleterious effects of monocropping, adopted in the 1960s in order to meet the strong international demand for grain. Farmers abandoned crop rotation which included a fallow period during which land was left to "rest" and be naturally fertilized by cattle droppings, and switched to intensive production of wheat and soyabean. By 1986, erosion was estimated to have affected 13.5 million hectares, or about a third of the pampas and to cost \$100 million a year in falling maize yields alone. Another \$20 million a year was needed to dredge ports silted up with soil swept into rivers by rainwater.<sup>6</sup> Degraded soil loses its ability to absorb rainwater, which instead courses across the land, carrying away fertile topsoil. A growing number of farmers are adopting alternative farming techniques, such as contour farming, no-till farming and the traditional crop rotation (*see Annex*).

22. There exist certain topographical restructuring techniques specifically designed to minimize soil loss. Examples of structural investments towards the conservation of the resource base include gully-control structures, diversion drains and live windbreaks. In the case of rice, for example, terracing not only minimizes the risks of erosion but actually strengthens the natural topography. Recent coffee plantations have been established in Brazil by planting seedlings along contours in elevated areas instead of in the traditional perpendicular con-

figuration, while the ground areas between trees have been seed with grass. The combined use of these two techniques has cut erosion significantly.<sup>7</sup>

23. In Viet Nam, agroforestry, especially the replanting of a native tree which had become increasingly uncommon in recent years, was being considered as a means of improving the usefulness of low-quality soil and as a supplementary source of income for rice farmers. The *Melaleuca* is a valuable tree resistant to rot and widely used in house foundations, dykes, dams and furniture. Its oil is used in local medicine, its flowers favored by honey-making bees, and its presence in the wetlands is believed to promote the growth of certain food fish. These trees were largely eradicated during the war through toxic chemicals, bombings and napalm sprayings and the area further de-forested after the country's reunification in 1975 by farmers adding drainage canals to establish rice fields. However, *Melaleuca* trees have since been replanted and currently cover approximately 116,000 hectares. The trees improve soil quality by drawing up acidity components from the soil; they protect the water table by filtering pollutants with their roots.<sup>8</sup>

24. Planting the deep-rooted gum arabic tree has also proven effective in stabilizing soil. In the Sudan,<sup>9</sup> where monocropping and heavy mechanization had been introduced, a practice still followed in certain areas in spite of the fragile and erosion-prone soil structure, this tree has been very useful in the maintenance of soil. In addition, the tree provides an excellent cash crop, promotes faster vegetation growth in the immediate vicinity, and improves the supply of forage and firewood to local families.

#### ***B. Alternatives to the use of agrochemicals***

25. Unlike erosion - which is an on-going battle between farmers and the forces of nature and which therefore calls for fixed investments in physical structures and permanent changes in planting techniques - plant pest attacks and disease epidemics may or may not occur, in varying types and intensity, during any given season. Therefore chemical applications should, in principle, be carried out in response to needs which change from season to season. In the pursuit of assured maximum productivity and flawlessness in produce appearance, however, modern farmers often resort to routine application of artificial inputs regardless of the actual need. It has been noted that such application tends to promote dependency of crops on these products. Compounded by intensive farming techniques, long-term and excessive use of artificial fertilizers tends to make the soil lose its natural capacity to regenerate, necessitating the application of increasingly stronger and heavier doses. The use of agrochemical pesticides routinely applied as a preventive measure, rather than as a therapeutic tool, is believed to be the cause of the evolution and spread of more resilient and damaging pest strains, requiring in turn more potent chemical treatment.

26. The use of agrochemicals in developing countries has never reached the same level as in industrialized countries' agriculture. The reasons are varied. Foremost among them are the limited purchasing power of farmers in developing countries, problems of logistics, and lack of an efficient agricultural extension infrastructure. Nevertheless, negative impacts of agrochemical use on soil and water through contamination are widespread. This is often the result of improper use, including over-applications by farmers who have the purchasing power and access to agrochemicals but not the requisite knowledge concerning modern agricultural techniques. As a result, around 20 million people in developing countries are affected by chemical poisoning each year.<sup>10</sup> These poisonings commonly result from handling pesticides without protective clothing, spraying

pesticide fumes without appropriate masks, eating food covered with pesticide residues or using pesticide containers to store food or water. The full scale of the problem is difficult to assess, but in Brazil's Salvador region alone, 300 pesticide poisonings and 14 deaths were reported during a two-and-a-half year period beginning January 1986. Not mentioned are the cases of slow poisoning wherein the victims gradually go blind, become debilitated, or develop cancer. Health hazards resulting from indiscriminate use of highly toxic agrochemicals are not confined to plantations workers. Laboratory testing of cocoa beans has found traces of controversial pesticides even in the beans themselves, potentially affecting the consumers.

27. Achieving larger net earnings by reducing costs through drastic cuts in agrochemical use and judicious selection of plant mix and concurrently increasing revenues through better-quality farm outputs has proved feasible as shown in several farm experiments, including an FAO integrated pest management project in Indonesia.<sup>11</sup> During the project's first year of operation, pesticide use was cut by 65 per cent while yields continued to rise. This finding is supported by research on cocoa production in Ghana which likewise suggests that high yield levels attained through large quantities of chemical inputs could also be achieved and sustained when a combination of good husbandry, integrated pest management and minimal use of pesticides is practised.

28. Such practices are also being introduced into the banana production sector in Costa Rica, which until recently was one of the most pesticide-intensive agricultural production practices in the world. This had prompted environmentalists to point to pesticides as the country's top environmental problem. Talk of an international boycott against Costa Rican bananas in 1991 led the Government and the multinational banana growers to create a new environmental division within the national growers' cooperative, Corbana.<sup>12</sup> Its task was to investigate pest-resistant banana strains and to canvass ways to reduce routine applications of pesticides. Its recommendation of checking banana trees carefully for pest problems and spraying as needed rather than on a set schedule would cut the number of aerial fumigations by half.

29. In response to the growing interest in integrated pest management and incessant calls for alternative approaches to pest control, pesticide manufacturers have been focussing their research activities on the natural life and reproductive cycles of crop-damaging insects. The new generation of pesticides being introduced into the market today have been developed along the lines of selective elimination rather than simple mass eradication. New chemicals, while being harmless to humans and plant life, can disrupt the reproductive cycles of certain plant pests. Manufacturers are also experimenting with the use of genetically-engineered naturally occurring bacteria, or microbials, which act as toxins to certain insects.<sup>13</sup> Because of insects' ability to build up resistance to a given form of pesticide, whether natural or chemical, it is important that research and development activities cover as wide a range of alternatives as possible, so that methods to ensure disease- and pest-free crops are found.

30. One of the new approaches being developed at the Caribbean Agricultural Research and Development Institute (CARDI) capitalizes on the resistance-building capacity of insects. The objective is to control the diamond-backed moth whose caterpillars can eat away entire cabbage patches.<sup>14</sup> By optimizing the pesticide-resistance trait of the natural insect enemies of the moth and therefore enabling them to survive the sprayings made when the cabbages are still young, researchers reason that these insects will remain to attack moth eggs and



caterpillars. Further spraying on cabbages can therefore be minimized or eliminated altogether.

31. In Africa, the Consultative Group of International Agriculture Research's Benin-based Biological Control Programme (BCP) for Africa has been identifying and locating the predators of some of the continent's crop-damaging insects. Overcoming the initial resistance of farmers to the idea of another insect being air-released on their fields was a major obstacle. Nevertheless, the demonstrated success of the technique against the cassava mealy bug has since won many converts to the programme. With the introduction of predator wasps in each of the 19 African countries where the pest was released, crop losses have fallen from 50 per cent or more to less than 20 per cent.<sup>15</sup>

32. Use of natural predators, however, is a relatively new area where expertise and knowledge are still being compiled. It is also a time-consuming, difficult and expensive operation; researchers must first make a search, sometimes world-wide, for an indigenous environment in which the exact species of pest can be found. Thereafter, they must determine which of its predators in that ecosystem might work best in the target environment. The application of this technique has so far been limited to combatting recurring attacks of the same pests, but its use is expected to extend to preventive measures as more in-depth knowledge is accumulated of pests' roles in the natural ecosystem.

33. There may also be damages in employing genetically altered creatures because some environmental "spills" could arise from within agriculture itself. The culture of genetically-engineered giant snails, otherwise known as the golden kuhol, was introduced in the Philippines during the mid-1980s to generate supplementary income. Quickly it became a popular backyard project throughout the country. But as the promised export market failed to absorb the escargot, culture pens were soon unable to contain the fast-growing and rapidly-multiplying molluscs. Escapees found their way to neighboring farms, and floods transported an even larger number to farther farms. Soon most ricefields were menaced. By January 1989, about 400,000 hectares or 11 per cent of the total rice areas in all regions of the country were infested; by October of the same year, the affected area increased to 500,000 hectares. In almost all reported cases, the snails inflicted damage on newly transplanted rice and directly seeded crops, destroying approximately 50 to 80 per cent of the potential harvest. Its extermination cost a 20-25 per cent increase in farm production costs.<sup>16</sup>

### *C. Treatment and recycling of agricultural and agro-industrial by-products*

34. Agricultural waste is often left to rot or is burned. Apart from undesirable local pollution effects, there is also methane and carbon emissions into the atmosphere. The decomposition of organic matter in paddies is estimated to account for as much as a quarter of the methane released into the atmosphere. The International Rice Research Institute (IRRI) has thus included "cleanliness" as one of its criteria in gene selection, different varieties exhibiting varying capacities for oxidizing methane resulting from the decomposition of organic matter in paddies.<sup>17</sup>

35. In order to increase the value-added of their products, most commodity-exporting countries accord importance to agro-industrial processing. The improper disposal of waste generated by related activities has triggered a host of environmental problems, ranging from pervasive product odor to water contamination. Various measures have been undertaken to resolve this problem. Apart from command and control measures specifically formulated to regulate tech-

niques applied and reduce effluents, uses are sought for by-products which are potentially detrimental to the environment. Treatment of by-products before disposal or epuration of polluted water are other areas of intense research. Examples of initiatives along these lines are given below.

36. When partially fermented and moist coffee pulps are thrown haphazardly into ravines, they often trigger organic chain-reactions and provoke widespread environmental degradation. In El Salvador and Costa Rica, for instance, coffee pulps composted into organic fertilizers are either sold to horticulturists or applied to coffee plantations. In neighboring Nicaragua, however, the use of composted pulp as organic fertilizer is not generally practised. Certain depulping stations in El Salvador supply coffee farmers with composted coffee pulps in order to ensure the quality of the next harvest. Composting, however, is a time-consuming operation; application of pulp which has not been composted thoroughly could result in high oxygen intake, growth of scolyte and decline of soil pH. A pulp-compacting machine capable of reducing pulp volume by 50 per cent is being developed and tested in these three countries. It facilitates storage and conversion into organic fertilizer, livestock feed and cooking fuel. Also being improved are compost beds which hasten the process of composting coffee pulps and other farm residues.<sup>18</sup>

37. Another coffee processing technology being developed for Central American countries is a biodigester which combines both water epuration and biogas production functions. Direct evacuation of water used in depulping and washing coffee cherries into water sources is a principal source of water contamination in the region, and has earned the coffee processing sector its reputation as the most polluting agro-industry. The 13 depulping centres in the Matagalpa region of Nicaragua, for example, are estimated to pour between 30,000 to 60,000 cubic metres of used water into the Río Grande de Matagalpa. The Río Grande de Táricoles,<sup>19</sup> which runs through Costa Rica's San Jose region where the depulping stations account for 60 per cent of the country's total coffee processing capacity and which empties into the Pacific Ocean, is devoid of all life. The problem of water contamination is worsened by the fact that coffee harvest coincides with the dry season. To be fully effective, at least 95 per cent of the pollutants in water used in coffee processing should be removed before it can safely be emptied into water bodies. Further improvements, such as the use of aerobic bacterial filters, are being explored. Another possibility under consideration is draining used water into pre-plantation areas as a form of irrigation.

38. An example of making use of water used in coffee depulping and washing is the National Federation of Colombian Coffee Growers' 1991 Indicative Plan on the disbursement of its "Fund for the Protection and Recovery of the Environment" which includes as one of its programme components, a water decontamination plan to treat residual water from coffee processing. Contained in the plan is the construction of oxidation vats and biodigestors, the use of aerobic and anaerobic bacteria, and the building of trenches for coffee pulp and maggot production.

### *III. Inter-sectoral linkages*

39. In most areas of the world, farm lands are increasingly adjoined to agro-industrial processing plants and industrial areas. They are also affected by urban expansion. The advantages offered to the affected population in terms of employment and improved social services by the presence of industry and urbanization are often counterbalanced by the environmental costs of such land-use activities, especially in terms of soil, water and air pollution from untreated factory emissions and urban waste. Competition over use of water resources is also frequent. Land clearance for roads required to service these non-farm sectors may have detrimental effects for farming. The emergence of some diseases and the loss of a cultural heritage may also be counted among the "environmental" costs.

#### *A. Encroaching urbanism and industrialization*

40. Real estate developments often have the effect of raising the price of land to a level where farming becomes economically unaffordable. In the competition over land, farmers usually lose, especially given the current low level of commodity production prices which depresses the relative price of land for agricultural use. Those who keep their farms often find themselves facing new problems. Among these are industrial and urban pollution, including vehicle emissions which are known to stunt plant growth and even render produce unfit for consumption; scarcer and probably more expensive water supply; and even limited exposure to the sun. Those who leave their land have the option of abandoning farming in favour of insertion into urban economic activities, or of re-establishing a farm where land is still affordable but most probably less suited to farming. Given the chronically rampant unemployment that characterizes metropolitan areas in developing countries, the first option may not be possible for many farming families. The second, however, often results in the clearance of forests and resettlement into fragile zones.

41. The harmful environmental effects of urbanization on the environment, as manifested through the agricultural sector, are being illustrated in Thailand where real estate inflation in booming cities has led developers to muscle in on suburban farm lands. Farmers who are squeezed out in the lowlands in turn take over mountains. Clearance and farming activities upland have triggered a spate of problems for lowland settlements, among which are the quality and adequacy of water supply.

42. Commercial farming interests, too, are becoming increasingly attracted to upland Thai properties. Since the mountain people never had legal title to their lands in the first place, "sale" of their farmlands is no more than informal renunciation of usage rights, rather than transfer of ownership. This hastens the disappearance of a tribal lifestyle which stressed harmony with nature. The cycle of rotational cultivation practised for centuries by the Karen tribe was integrated into their calendar and included intervening periods of fallow fields. Such practices are not followed by the new settlers.<sup>20</sup>

43. Large areas of agricultural and common land in the Jakarta area of Indonesia are being converted into luxury housing estates and golf courses, depriving numerous families of their means of livelihood and, as environmental experts point out, posing a potential threat to local water resources through the enormous doses of agrochemicals routinely applied to give golf courses their thick carpet of grass and impeccable appearance. The Government has imposed

a ban on further golf course construction in Jakarta and West Java pending the issuance of new regulations.<sup>21</sup>

44. When industries are implanted within agricultural areas, the pollution generated by these industries often contaminates natural resources such as soil, water and air, and has negative impacts on agricultural productivity. There is, in addition, a social impact as the surrounding farming community often becomes dependent on these industries for employment. In many places, toxic wastes from industrial plants are routinely discharged into water sources, causing contamination of drinking water sources. Additionally, when polluted waters are used in irrigation and their toxic contents are absorbed by vegetables and other crops, this renders the produce toxic and unfit for human consumption. Public consciousness of the situation is an important step towards the resolution of the problem.

45. In the Huasco Valley in northern Chile, the community acted together and successfully brought industry under control in order to protect their olive groves. Harvests from these olive groves had been slowly dwindling from 6,000 metric tons a year to 1,000 since the opening of an iron pellet plant in the area in 1978. The leaves of the trees were so encrusted with iron dust that they became pitch black in color and leapt to a magnet like pins. It took several years for the farmers to identify their dwindling harvests with the pellet plant and, because the plant had since become the region's biggest employer and its biggest benefactor of social services, even longer to obtain a legal injunction for the plant to curb its emissions without losing jobs. The Mining Research Council began monitoring emissions at the plant in early 1990, and found that it was emitting more than 37 metric tons of particulates, principally iron dust, every day. In August 1992, Chile's Supreme Court ruled that the pellet plant should curb its emissions in line with new regulations which were scheduled to come into effect the following October. By resorting to legal recourse at the risk of losing their newly-found means of livelihood, the farmers contributed to the formulation and adoption of these regulations, and set a precedent for other farming communities threatened by proximity to mining smelters and refineries.<sup>22</sup>

### ***B. Tourism***

46. For many countries both developed and developing, tourism is an important source of foreign revenue. For developing countries endowed with sandy beaches and sunny weather, the promotion of the tourist industry is often top priority on the development agenda. However, this can have negative impacts on agriculture in the form of escalating land prices, inadequate waste treatment facilities, destabilizing effects of roads on topography, as well as other socioeconomic consequences like higher prices of basic necessities and loss of traditional social values. From an environmental point of view, competing demands on water supply have the most serious consequences.

47. The erection of hotels, especially large, luxurious ones, often includes the digging of deep wells to ensure adequate and steady water supply. Direct disturbance of the water table has the effect of accelerating and aggravating surface water salinization, a problem prevalent along coastal agricultural areas. Like the presence of industrial plants in agricultural areas, tourism also offers to surrounding communities the double-edged opportunity of employment. Because the industry attracts and selects young people in general, only the elderly and young children are left to tend the farms under conditions that become more difficult.

48. A new and increasingly popular type of tourism, dubbed "eco-tourism," is advanced on the dual objectives of income-generation and wildlife or natural resource protection. Properly managed it can have positive consequences for both the environment and the agricultural community. In Viet Nam, for example, ecotourism has been proposed as the solution to the conflict between several international nature conservation groups and the thousands of impoverished farmers resettled by the Vietnamese into the wetlands of Dong Trap province in order to relieve population pressures elsewhere in the country. The conflict centres on the use of a 9,000-hectare nature reserve set up to protect the feeding ground of the eastern Sarus crane, which until about seven years ago was feared to have disappeared.<sup>23</sup> The highly acidic soil of the areas allotted to farming does not produce the desired yield of rice, so farmers often make incursions into the reserve in a bid to claim more acreage.

#### *IV. Government policies and programmes*

##### *A. National framework*

49. The concept of environmental protection is universally embraced at both the international and national levels as attested by international environmental agreements and the environment-related legislation enacted in most countries during the past few years. Given other development needs and priorities such as poverty alleviation, however, protection of the environment can receive less attention in practice than on paper. Legal measures designed to protect the environment often go unheeded, and special bureaus created to monitor the enforcement of these measures are often inadequately staffed owing to lack of resources. The institutional and legal framework, such as land-tenure systems, can also be detrimental to environmental protection in modern agriculture.

##### *1. Land ownership and tenure*

50. There are areas in developing countries which fall under the traditional concept of communal land ownership. Often these areas are environmentally fragile and unsuitable for agriculture. In the past when tribal identity was stronger, the role of tribal leaders more important, and the requirements of cash economy less obtrusive, this concept served to protect the environment from overuse and destruction. However, there may also be inherent disincentives under communal land ownership to practicing soil conservation, particularly when the rights to land use are temporary and any permanent modifications seem a menace to communal land ownership. In any case, the bonds of tribal authority and tradition have become looser while the demand for land has risen with continuing population growth and with the desire for surplus in agriculture. Finally, the common-property nature of grazing zones may permit increases in the ratio of animals to land area beyond that which would theoretically be the case under private ownership of land, with the consequences of overgrazing. In the Sahel, where drought and population pressures are significant, all of these complications owing to the absence of land markets have been experienced.<sup>24</sup>

51. Government criteria for awarding claims on public lands can also influence the rate of encroachment on wildlands. Such has been the case in Côte d'Ivoire for instance,<sup>25</sup> where, in a bid to expand cocoa and coffee production, the gov-

ernment not only guaranteed purchases and floor prices but also gave free access to uncultivated areas, making them "belong to whoever uses them." Settlement was characterized by the use of slash-and-burn methods of land reclamation and of rudimentary farm tools and by a nomadic type of agriculture. Although the small-scale nature of the farms limited deforestation to some extent, soil conservation measures, whether in terms of organic inputs to ensure soil integrity or of physical structures to minimize erosion, were rarely applied. When the land became depleted, the settlers simply moved on to other wildlands. This policy served as a magnet to a flow of migrants from neighboring countries.

52. In the Sudan,<sup>26</sup> land is officially owned by the State which allocates rights to cultivate. Tenure is ensured only if cultivation is maintained, which discourages land fallowing. Marginal lands are not excluded from cultivation, although there are measures to protect them. One of these measures is the "demarcation" of certain areas, which allows varying levels of mechanization on lands leased from the State. In areas where levels are defined as below the standards required to sustain environmental integrity, problems arising from use of agricultural machines are particularly severe. Even in demarcated areas, the leasing conditions are sometimes ignored and recommended cropping patterns not followed. When the land becomes unproductive, the operators simply abandon it and move to other areas.

## *2. National agricultural programmes/rural extension programmes*

53. For many farmers in developing countries, the extension workers provide the principal link between farming as it is being practiced and farming as it could or should be done. Through such agencies as the Food and Agricultural Organization (FAO), environment-friendly farming is being introduced into the training and retraining programmes of these workers. The International Fund for Agricultural Development (IFAD)'s programme of Technical Assistance Grants<sup>27</sup> also includes support for alley farming, biological control of pests, traditional crop improvements, farmer-managed irrigation systems, rain-fed rice-based systems, agroforestry in semi-arid lands, multi-purpose trees, soil and water conservation technologies and extension strategies for minimizing risks in rain-fed agriculture.

54. Among the techniques which are currently being advocated are integrated farm management based on soil analysis and agrochemical-free pest/disease control. Careful testing of techniques and crops for effectiveness and viability before they are introduced is also emphasized. Without such testing not only is the introduction of new practices often useless, but also the credibility of the entire programme may suffer and the likelihood of advice being followed in future undermined. The extension programme should also be equipped with a monitoring and evaluation system, with feedbacks from farmers as an integral component especially during its early phase.

55. Extension workers also serve to integrate the environmental conservation activities undertaken by individual farmers into a coherent effort. This is important in the case of agrochemical use as well as in erosion-control measures. If, for instance, one farm constructs bunds or embankments but the neighbour does not, the runoff from the neighbour's farm can overwhelm and negate the conservation measures of the first. Additionally, large-scale conservation structures might require a great deal of investment on the part of farming families in terms of materials and labour inputs as well as complementary investments at the community level. For example, a farmer who plants live windbreaks may have

to fall back on the farming community for assistance at first, when watering is especially critical for the survival of the young saplings.

56. In the Dominican Republic, a pilot extension service project has been set up to train a small cadre of young men and women with the knowledge and leadership skills necessary to teach sustainable agriculture methods to farmers. Trainees at the Regional Centre for the Study of Rural Alternatives (CREAR in Spanish) are drawn from the ranks of local farmers and the programme is tailored to local conditions. The "barefoot agronomists," as the CREAR graduates are known, work alongside their government counterparts. They are considered more effective because (a) they are from the region itself and familiar with the community and its problems as opposed to the agricultural extension agents who are usually trained at big urban universities; and (b) each one works with less than 25 of his or her own neighbours, whereas for the official programme the ratio is 1:1000. Before the project, many farmers in the pilot area, like many farmers in developing countries, had no choice but to turn to agrochemical salesmen for advice. In the ten years since the Centre was opened, the farmers in Rio Limpio are winning the war against soil erosion --- a problem typical of mountain lands --- by building terraces and planting trees. Many now use organic methods to fertilize crops and control pests instead of costly and dangerous chemicals and are enjoying increased harvests.<sup>28</sup>

### *B. International influences*

57. The level and nature of activities in the export-oriented commodity-producing sectors are a function of international market prices. A decline in the market price, as is the case for many agricultural commodities during recent years, causes important social problems by aggravating poverty. It can also provoke effects on the environment, whether detrimental or beneficial. A case in point is the increasing incidence of farm abandonment, which increases the risks of soil erosion, and the growth of weeds, providing the conditions for the proliferation of crop-damaging insects. There are some, however, who view the interruption of farming as an opportunity for the land to rest and to regain its natural fertility.

58. In addition to market prices, there are other trade-related factors which affect export-oriented production. For example, in recent years, environmental and health consciousness as well as consumer lobby groups have gained importance and influence over markets. These tendencies affect demand and should be considered in the agricultural and export programmes.

59. Only a few years ago, organic food was considered a specialty product for vegetarians and for health-conscious consumers. The widespread panic over the alleged carcinogenic properties of Alar which was widely used in the treatment of apples has probably been a significant factor in promoting demand for organic food. Although this fear has since proved unfounded, it strongly advanced the preference for, and in some degree even the aesthetic acceptance of, fruits with less than perfect skin and shape. In 1990, the market for organic food in the United Kingdom was worth £120 million and expected to triple within a few years.<sup>29</sup> Two-thirds of the supplies were imported, with prices averaging 88 per cent more than those for conventionally grown produce.

60. Some developing countries have re-tooled their production and processing industries to fill this niche. For instance, coffee from the UCIRIC and ISMAM cooperatives in Chiapas, Mexico, which meets the production standards set up by International Federation of Organic Agriculture Movements (IFOAM) and

certified as such, fetches as much as 100 per cent more than the world market price of coffee from alternative trade organizations in Europe.<sup>30</sup> Meat from cattle grazing on pastures which do not threaten forests and are naturally maintained also commands premium prices. Mauritius is entering the market of environmentally-conscious Europe with organic sugar produced chemical-free from soil which has been allowed to rest for two years between sugar-cane plantings.<sup>31</sup> The country expects to export between one to two thousand tons annually to European countries. The United States, Canada and Zimbabwe have meanwhile expressed interest in the product.

61. Under the joint sponsorship of the United States-based Rainforest Alliance and the Costa Rican groups Fundacion Ambion and Tsuli Tsuli/Audubon, the Banana Amigo Project assists in the negotiation of a code of conduct that covers waste disposal, use of water and agrochemicals, reforestation and worker safety. It also promotes environmental practices with a "reverse boycott" by awarding a "Smart Banana" seal of approval to bananas grown in an ecologically improved manner. It hopes to persuade consumers to choose "Smart Bananas" even if they are blemished or smaller than other bananas.<sup>32</sup> Fruit bearing the first seals began appearing in grocery stores in early 1993.

62. The 1990s may see attempts to unilaterally enact laws imposing restrictions on the production and inputs of a wide range of products on the grounds of environmental protection. An example of this was the ban in the United States on tuna fish caught with a technique known to be hazardous to other species like dolphins and sea turtles; the ban has been declared illegal by a GATT panel. Owing to the GATT ruling, such official bans are unlikely to reoccur although there is growing concern about the increasingly powerful role of well-organized lobby groups. One particular worry, however, is that ill-informed prejudice could supersede scientific consensus or that false advertising could be used to discredit competing products, creating a form of trade restriction and imposing unwarranted burdens and marketing costs. In any case, by adopting agricultural practices which are basically "clean" and sustainable, commodity producing countries are better able to protect their exports from these possible threats and continue their production for many years to come which is what the concept of sustainability tries to assure.



## NOTES

1. Plant genetics constitutes one of the most promising keys to the challenge of feeding the growing human population while maintaining the level and degree of natural resource use. Although in line with the prevailing priorities of the times, initial research had been focussed on the quest for maximum productivity at minimum costs, activities are now being increasingly geared towards enhancing other plant traits such as pest resistance, resilience, and adaptability to adverse soil conditions. These characteristics reduce the need for environmentally harmful chemical inputs.

2. The Economist Intelligence Unit Country Profile 1993/1994: Bangladesh.

3. International Herald Tribune, 15 July 1993. "For green revolutionaries, a Latin American triumph." Latin America's grassy plains, the *cerrado*, are centred in Brazil; they cover more than 200 million hectares. This savannah had such acid soils that until recently it was considered unfit for farming. Even when lime was applied, the absence of rain for periods longer than seven to ten days saw the roots die and plants collapse.

4. CIAT International, Vol. 11 No. 2 of October 1992, "Savannas: Where the Grass is Greener than Ever." A publication of the Centro Internacional de Agricultura Tropical (CIAT).

5. UNCTAD document TD/B/CN.1/15, 22 September 1993. The *cabruca* is the traditional cocoa agroforestry system largely practised in Brazil's Bahia region. Cocoa seedlings are planted within native forest wherein floral substrata and about 90 per cent of the original tree cover have been removed. Cocoa is shaded by native trees representative of the threatened Atlantic Forest. Although the *cabruca* system entails drastic modification in the structure and composition of species present in the original ecosystem, it is considered to be the least detrimental to the native flora and fauna among agricultural practices used on Brazil's eastern coast. The cocoa plantations function as "corridors" for wildlife migration between forest islands, allowing contact between groups and widening choices of potential territories.

6. Financial Times, 10 March 1992: "Profits under threat on crumbling pampas".

7. UNCTAD document TD/B/CN.1/15, 22 September 1993.

8. Financial Times, 8 April 1992: "Sticking a neck out to save the crane".

9. FAO Economic and Social Development Paper No. 110, "Agricultural Sustainability: definition and implications for agricultural and trade policy," Rome, 1992.

10. Financial Times, 18 October 1991. "FAO puts pest management to the fore".

11. *Ibid.*

12. World Watch Jan-Feb 1993, "Banana Split".

13. Financial Times, 27 October 93: "Assault on pesticides".

14. Financial Times, 28 June 1990: "Spare the pest-killer and kill the pest".
15. African Farmer, November 1990: "Building Safe Defences against Destructive Bugs".
16. Farm News & Views: a bi-monthly publication of the Philippine Peasant Institute, Vol. IV No. 4, September-October 1991.
17. COURRIER, No 14 March 1993. "Riz non polluant".
18. M. Jacquet, "La technologie du café, la valorisation des sous-produits et le traitement des eaux résiduaires dans trois pays d'Amérique centrale: Costa Rica, Nicaragua et El Salvador," published by the Institut de Recherches du Café, du Cacao et autres plantes stimulantes (IRCC). Montpellier, 1991.
19. *Ibid.*
20. Far Eastern Economic Review, 13 December 1990: "Of Cabbages and Cultures".
21. The Economist Intelligence Unit Country Report 3rd quarter 1993: Indonesia.
22. Financial Times, 12 August 1992: "A taste of one's own medicine".
23. Financial Times, 8 April 1992: "Sticking a neck out to save the crane".
24. R. Lent, "Non-market Institutions and Drought Adjustment in the Sahel," Département d'économie rurale, Université Laval. (unpublished paper, undated).
25. B. Losch of CIRAD-SAR Montpellier. Paper presented at the "Table Ronde de Bingerville" from 30 November to 2 December 1992, entitled La relève incertaine de la régulation étatique dans les filières café et cacao en Côte d'Ivoire.
26. FAO Economic and Social Development Paper No. 110, "Agricultural Sustainability: definition and implications for agricultural and trade policy," Rome, 1992.
27. International Fund for Agricultural Development (IFAD) information packet "From Destitution to Entrepreneurship" by J. Power.
28. World Watch, Jan-Feb 1993, "Home-Grown Farming Success".
29. Financial Times, 6 June 1990. "Organic food market worth £120m a year".
30. Letter dated 31 May 1992, Bach of U-landsimporten to UNCTAD/Arda.
31. African Business, April 1993 "Mauritius taps a growing 'green' sugar market".
32. World Watch Jan-Feb 1993, "Banana Split".

## Annex

Examples of agricultural technologies with high sustainability potential which are both productive and inexpensive:

- Intercropping, which involves the planting of two or more crops on the same land surface during the same planting season. The mix of crops is determined by their different food nutrient needs and their mutual compatibility. Often a legume crop is used to provide nutrients to the second crop. Interactions between and among crops may also serve as natural forms of pest control and weed deterrence;
- Rotation, whereby two or more crops are grown on the same piece of land in successive planting seasons. Benefits derived from this practice is similar to those of intercropping;
- Agroforestry, a form of intercropping in which annual herbaceous crops are interspaced with perennial trees or shrubs. The deeper-rooted trees draw water and nutrients without competing with the annuals over shallower food sources. The bigger trees also provide shade and mulch, while the herbs provide the ground cover needed to control weed proliferation and to minimize erosion. The nitrogen-fixing leucaena tree, for example, grows quickly, providing fodder and high protein leaves in its first year and usable timber within five years. In Nigeria, Belize and Borneo, new leucaenas have made long-vanished vegetation thrive again by drawing moisture and minerals up to the topsoil with their long taproots. Revitalizing depleted lands could ease pressures to raze forests and to reclaim mangroves and fragile areas for croplands (*Source: Newsweek, 30 November, 1992, "Miracle Plants"*);
- Silvi-pasture, in which perennial trees or shrubs are combined with grass and other fodder suitable for livestock grazing. Plants, including trees, grass and herbs, could be selected to provide for the different food preferences of mixed livestock;
- Green manuring, the practice of growing legumes and other plants for the express purpose of fixing nitrogen from the air and incorporating them into the soil for the succeeding crop. Examples of green manures are Sesbania, sweet clover, alfalfa and the fern Azolla which contains nitrogen-fixing blue-green algae;
- Conservation tillage, in which the seed is placed directly in the soil with little or no preparatory cultivation, thus minimizing soil disturbance which in turn

lessens runoff and loss of sedimentation and nutrients;

- *No-till farming*, a method similar to conservation tillage which was recently developed in the United States. In this technique, stubble is left standing after harvest and the next crop sown directly on top, thus conserving the soil by not disturbing its structure. About 500,000 hectares of Argentine farmland are now being cultivated under this technique, an area which has grown three times in three years. The main reason for the technique's popularity among farmers is its affordability rather than its friendliness to the environment. (Financial Times, 10 March 1992: "Profits under threat on crumbling pampas");
- *Biological control*, or the use of natural enemies, parasites or predators to control pests. If the pest is exotic, its enemies may be imported from the country of origin of the pest; if indigenous, various techniques are used to augment the numbers of existing natural enemies. Ugandan wasps, for instance, were successfully used in Brazil to control coffee borer attacks in the early 1980s. The "fertilizer tree" cited above, the leucaena, was itself on the brink of being wiped out in much of Asia by a sucking insect called psyllid. The tree and its promise were rescued when, in 1987, researchers were able to identify and use a type of parasitic wasp as the psyllid's natural predator. ("Miracle Plants," *op. cit.*);
- *Integrated pest management* which calls for the use of all appropriate techniques of controlling pests in an integrated manner such that natural controls are enhanced rather than destroyed. Chemical pesticides are used sparingly and selectively so that natural enemies are not threatened.

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Source: FAO Economic and Social Development Paper 110.