Sustainable Land Use and Sustainable Development: Critical Issues

Karen Liu and Chung-Chi Lu[1]

Abstract: Sustainable agriculture has emerged as a key issue in agricultural development and natural resource management because of widespread and growing concern about the seriousness of degradation of the world's natural resource base and ever-increasing pressures on these resources from continuing rapid population growth. This paper examines the changes in land use and the problem of tropical deforestation affecting the world's land resource base for sustainable agricultural development. Global land-use changes have been slow in the last decade. However, changes in land-use patterns have been significant in many developing countries, especially the conversion of forest land into agricultural land to meet increasing demand for food and fibre. It is estimated that over 11 million ha of tropical forests are cleared every year in Latin America, Asia, Africa, and the Pacific Islands. The most serious consequence of tropical deforestation is soil erosion, which may greatly increase after forests are cleared. It is also apparent that tropical deforestation is contributing to global climate change. Improved agricultural sustainability, combined with policies to protect natural resources, is urgently needed to support the rapidly increasing population in developing countries.

Introduction

Achieving agricultural sustainability in developing countries has become one of the most important issues in agricultural development in recent years because of growing concerns about rapid population growth and the accelerating decline of economically viable arable land. This paper examines the changes in land use and the rate of tropical deforestation affecting the conditions of the world's land resource base for sustainable agricultural development. The pressures of population growth and its adverse effect on land resource and food demand are discussed. Possible actions and policy interventions for a sustainable land resource base are suggested.

The natural resources of a country are its most valuable endowment. However, only recently have scientists become fully aware that growing population pressures have led to the narrowing of the resource base throughout the world. The observed result is that human-induced degradation of land resources has worsened largely due to the inadvertent, inappropriate use of technological innovations. It is estimated that each year 6 million ha of dryland are removed from production by mismanagement and 11 million ha of forest land are degraded by clearing. There are three major ways in which this is occurring: slash and burn farming in tropical areas, increased land conversion in temperate climates for settled agriculture, and high rates of inappropriate timber harvesting. Such a vast and growing degradation of the world's natural resource base has led to an increasing awareness of the importance of having a sound, sustainable natural resource base or environment.

Sustainable agriculture has emerged as a key focus in agricultural development and natural resource management because of growing concerns about the seriousness of degradation of the world's natural resource base and increasing pressures on those resources from rapid population growth. Because of the Green Revolution, there have been major successes in South and Southeast Asia in the past 20 years in increasing crop yields by the introduction of new high-yielding crop varieties and the use of inorganic fertilizers and pesticides. However, there is still a general perception that agriculture in developing countries is not able to respond to current needs for increased food and fibre production due to continuing degradation of natural resources—soil erosion, deforestation, desertification, and water contamination.

World Population Growth

The world's population continues to grow rapidly, driven by very high growth rates in many developing countries. During 1950–89, global population more than doubled from 2,500 million to 5,200 million people, and another 1,000 million people will be added before the end of the next decade. Although some developed countries' population growth rates have fallen in the last decade, many developing countries are still growing rapidly because a large portion of their populations is in its reproductive years and contraceptive techniques are not widely used; e.g., India. Table 1 presents data on current and projected world population and its labour force. It highlights the relatively high population growth rates in developing countries. For example, Africa has the world's highest annual rates of population growth (3 percent overall, with 21 countries above 3 percent), followed by South America (above 2 percent in most countries). Asia, the most populous continent, also has a rate of increase (1.85 percent) that is slightly higher than the world average.

The increasing trend in world population growth is projected to continue well into the foreseeable future. According to recent projections by the United Nations, world population will increase by 3,200 million persons during 1990–2025. Of this growth, more than 90 percent will occur in the developing regions of Africa, Asia, and Latin America. Because of this ominous trend, these regions' share of total world population will increase from 67 percent in 1950 to 84 percent in 2025.

The rapid and continuous population growth and very large numerical increases in world population have several potentially adverse consequences. One major impact is heightened food demand. Another significant impact is the reduced sustainability of natural resources and resulting degraded quality of the environment.

In terms of world food production trends, cereal production has increased over 70 percent since 1965. It has also more than doubled in developing countries, with Asia leading as a result of the Green Revolution. However, the rate of increase in cereal production has slowed significantly since 1983, indicating that the major gains have already peaked. In terms of per-capita food production, China and the other centrally planned economies of Asia have shown the largest gains. Food production in other Asian nations is only slightly ahead of the population curve. In Latin America and the countries of the Near East, increases in food production appear to be staying only about even with population growth. By contrast, Africa is still continuing a long-term decline in per-capita food production that began in the early 1970s, with no reversal of this adverse trend in sight. Between the 1976–78 average and the 1986–88 average, per capita food production declined by 8 percent. Because of continuing rapid population growth in African countries and slow or non-existent agricultural productivity increases, it is becoming increasingly difficult to maintain agricultural development while at the same time providing adequate food supplies at reasonable prices. Therefore, one of the most important factors for sustainable agricultural development is the ability to balance the needs of larger populations in developing countries with the rate of increase in productivity of their natural resources.

Global Land-Use Changes

Until recently, the history of humankind could be regarded as a process of appropriate natural resource use. However, the trend has shifted more recently to one of over-exploitation. The land base can be classified into urban, crop, range, pasture, forest, wetlands, and other categories. At the global level, shifts in land-use patterns have been gradual in the last decade. However, local or regional changes in land-use patterns have been very dramatic, especially in terms of the accelerating rate of conversion of forest land into agricultural land in an effort to meet the rapidly increasing demand for food and fibre in the developing countries.

Table 1—Size and Growth of Population, Labour Force, Share of Urban Population

	Population (millions)			Average Annual Population Change (percent)			Urban Population as a Percentage of Total			Total Labour Force (millions)	Percentage of Labour Force in					
											Agriculture		Industry		Service	
	1960	1990	2025	1965–70	1975–80	1985–90	1960	1975	1990	1985	1960	1990	1960	1990	1960	1990
Africa	281	648	1,581	2.63	2.95	3.00	18	25	35	214	78	69	8	12	14	19
N. and C. America	270	427	595	1.64	1.47	1.28	63	67	71	176	18	12	32	29	50	58
S. America	147	297	498	2.47	2.27	2.08	52	65	76	94	44	29	22	26	33	45
Asia	1,667	3,109	4,890	2.44	1.86	1.85	22	25	30	1,299	75	66	10	15	15	19
Europe	425	498	512	.67	.45	.23	61	69	73	226	28	14	39	39	33	47
USSR	214	288	352	1.01	.82	.78	49	60	68	143	42	20	29	39	29	41
Oceania	16	27	39	1.97	1.51	1.44	66	72	71	11	27	20	32	28	41	52
World	3,019	5,292	8,467	2.06	1.74	1.73	34	39	43	2,164	60	51	18	21	22	28

Table 2—World Land Area and Use, 1985–87, and Percent Change since 1975–77

	Total Area		Percent Change since 1975–77
	Million ha	Distribution (percent)	
Cropland	1,473	11	2.7
Permanent pasture	3,215	25	–0.2
Forest and woodland	4,074	31	–2.1
Other land	4,314	33	1.3
World	13,076	100	

Historically, increased food demand was met by enlarging the cultivated area. Although increasing yields have become more important since 1950, the cropland area continues to expand. Between 1964–66 and 1982–84, total cropland increased by 8.9 percent globally. The growth in total cropland between 1975–77 and 1985–89 has subsequently slowed, rising only 2.7 percent. There was an even greater percentage increase in many countries of Africa, Asia, Latin America, and Oceania, partly because of increasing population pressures (Table 2). However, the per-capita land area for agriculture has been declining due to the continuous growth of population. At the world level, without a major expansion of arable land, the world average of 0.28 ha of cropland per capita is expected to decline to 0.17 ha by the year 2025 under current population projections. In Asia, cropland per capita would decline to only 0.09 ha. For range and pasture land, the amount of land devoted globally to permanent pasture remained relatively stable (0.2-percent decline) between 1975–77 and 1985–89. However, intensity of rangeland use in many developing countries has increased as a result of rapid growth in human and livestock populations.

The increase in cropland has come at the expense of rangeland, forests, wetlands, and other areas that are both economically important and ecologically fragile. Urbanization and industrial development are the two major threats to the loss of existing cropland. Losses of agricultural land to other uses are most pronounced in the densely populated, rapidly industrializing countries of East Asia, including China, Japan, South Korea, and Taiwan, where nonfarm uses claim roughly 500,000 ha of cropland each year.

Effects of Tropical Deforestation and Soil Erosion on Agriculture

Nearly all forms of global environmental degradation are adversely affecting agricultural production. The two most significant forms of land resource degradation include tropical deforestation and soil erosion. Since 1950, a period when population has been growing rapidly in developing countries, deforestation has been concentrated in the tropics.

Forests cover approximately 31 percent of the earth's land surface and are vital to both human activities and biological processes (Table 3). About half of these forests are in developing countries in the tropics. Today, the highest rates of land-use changes are also occurring in the tropics, where human populations are rapidly increasing.

Table 3—Distribution of Cropland and Forest Land among Major World Regions, 1985–87

	Total Land Area		Cropland		Forest and Woodland	
	Million ha	Share (percent)	Million ha	Share (percent)	Million ha	Share (percent)
Africa	2,964	22.7	185	12.6	689	16.9
N. and C. America	2,138	16.4	274	18.6	685	16.8
S. America	1,753	13.4	141	9.6	905	22.2
Asia	2,679	20.5	451	30.6	540	13.3
Europe	473	3.6	140	9.5	157	3.9
USSR	2,227	17.0	232	15.8	943	23.1
Oceania	843	6.5	50	3.4	156	3.8
World	13,077	100.0	1,473	100.0	4,074	100.0

Excessive tropical deforestation has become an urgent, global environmental issue. Based on a 1980 FAO assessment of tropical forestry research, it is estimated that over 11 million ha of tropical forests are cleared every year in Latin America, Asia, Africa, and the Pacific islands (FAO, 1988). Several, more recent, studies show that levels of deforestation have

recently accelerated in Brazil, Costa Rica, India, Myanmar, the Philippines, and Vietnam. Forest clearing also increased sharply in Cameroon, Indonesia, and Thailand. Table 4 shows deforestation estimates for closed tropical forests in selected countries. Principal direct causes of tropical forest losses are their conversion and use for agriculture, fuelwood gathering by the rural poor, and poorly managed commercial logging. On a worldwide scale, the ever-expanding quest for food sources is the principal contributor. Other actions include the continued spread of shifting agriculture, clearing of closed forests for pasture, and heavy grazing pressures in the open forests of semi-arid regions.

Table 4—Deforestation Estimates for Closed Tropical Forests, Selected Countries

Country	FAO Estimates (1981–85)		More Recent Estimates		
	1000 ha	Annual Rate of Change (percent)	1000 ha	Annual Rate of Change (percent)	Period
Brazil	1,480	–0.4	8,000	–2.2	1987
Cameroon	80	–0.4	100	–0.6	1976–86
Costa Rica	65	–4.0	124	–7.6	1977–83
India	147	–0.3	1,500	–4.1	1975–82
Indonesia	600	–0.5	900	–0.8	1979–84
Myanmar	105	–0.3	677	–2.1	1975–81
Philippines	92	–1.0	143	–1.5	1981–88
Thailand	379	–2.4	397	–2.5	1978–85
Vietnam	65	–0.7	173	–2.0	1976–81

According to Brown (1990), soil erosion is slowly undermining the productivity of an estimated one-third of the world's cropland. Current estimates of annual losses of soil due to erosion are 25,000 million t globally. Soil erosion in Africa and South America is occurring at annual rates of about 7 t/ha due mainly to intensive cultivation and cropping. However, in the more fragile soils of developing tropical countries, the rapid rate of deforestation is the major factor contributing to soil erosion. Furthermore, soil erosion not only affects soil fertility but also causes degradation of aquatic resources through siltation.

Agenda for a Sustainable Resource Base

A massive international effort is needed in order to protect soil, conserve water, and restore the productivity of degraded land. To bring the world's population into balance with its resources and environment, the relationship between agricultural and population dynamics of developing countries must be brought back into equilibrium. This is fundamental for sustainable agricultural development. Two aspects of population growth affect natural resource and environmental issues: increased numbers of persons and higher per-capita income. While increased population numbers present one kind of environmental impact, higher per-capita income is of even more concern regarding the adverse effects on worldwide environmental change. According to recent UN population projections, world population will increase by 3,200 million people during the 1990–2025 period. Most of this growth will take place in the developing countries. If this increase in population is realized, we must accelerate our educational programmes and stress economic development on a worldwide basis. The challenge for sustainable development is not only to meet the needs for the increasing size of population but also to meet the needs for a better quality of life. Joint cooperative efforts to provide education, family planning, population assistance, and economic development by

national governments, international organizations, and the non-governmental organizations are essential to solving the world's population problem.

Comprehensive study of the soils, vegetation, climate, and the other physical resources of the country is also vital for land-use planning. The natural resource base must be surveyed and fully understood prior to or during the design stage to ensure that agricultural development projects are compatible with characteristics, properties, and capacities of the natural resource base to support sustainable agriculture. Resource mapping and geographical information systems as well as agroecological zoning are key ingredients for land-use planning for developing countries.

Development of policies and programmes on land resource conservation and environmental improvement is also vital to sustainable land use. Government authorities must reform policies that adversely affect farmers' use of land and their choice of technology, and must eliminate incentives that lead to forest destruction or growing of inappropriate crops on vulnerable lands. There is great need to build conservation and environmental improvement "incentives" into the economic and political system. Inappropriate or poorly enforced land-tenure systems can discourage farmers from conserving natural resources and investing in future productivity. At present, many countries do not have adequate laws to protect forests and rangelands from indiscriminate exploitation. For example, obtaining the clear title to land is often a problem in Brazil. In order to achieve sustainable land use, the constraints that threaten it must be alleviated.

Adoption of improved land use practices. Soil preservation is the most important resource for ensuring sustainability; loss of topsoil through erosion and a reduction in soil fertility by not replacing nutrients both turn a renewable resource into a nonrenewable one. Poor soil and water management in rainfed agriculture can cause severe land degradation. Positive steps that can be taken include adoption of conservation practices, shifting cultivation methods back to those traditionally practised in order to maintain soil fertility, expanded use of better technology and improved education, and employing low-input production practices, such as integrated pest management and best management practices. The proper balance of these measures can facilitate and maintain land resources.

Actions for sustainable forestry development. Because of the scale and adverse implications of continuing tropical deforestation, international organizations including the FAO, World Resources Institute, World Bank, and UN Development Programme surveyed forest conditions in the tropics. They formulated the "Tropical Forestry Action Plan," calling for an international commitment to reverse tropical deforestation. This plan includes work in five areas: forestry in land use, forest-based industries, fuelwood, conservation, and use of appropriate institutions to reach the people. The USA is also taking an active part in the worldwide effort to reverse tropical deforestation through the tropical forestry programme of the US Department of Agriculture's Forest Service.

Education and public awareness is one mechanism for changing direction on land resource management. It is important to build a public consciousness and awareness of the need for careful management of the resource base and then translate that consciousness into active policies and regulations. The educational process must be targeted to reach the public, particularly in developing countries, about the importance of a sound natural resource management programme for sustainable agriculture.

Conclusion

Sustainable agriculture for developing countries has become a crucial issue in agricultural development and resource management. Agriculture is an extremely important engine of economic growth in developing countries. It provides not only food, fibre, and fuel, but also employment and income, as well as the raw materials, capital, and additional resources necessary for the development of other sectors. However, the present and future capabilities of these countries to provide adequate livelihood and food security are threatened by rapid

population growth and degraded natural resources. Improved agricultural sustainability, combined with policies to protect natural resources, is therefore needed in order to support the rapidly growing population in developing countries.

Note

[1]US Department of Agriculture and US Agency for International Development, respectively.

References

Brown, L.R., *State of the World 1990*, N.W. Norton, New York, N.Y., USA, 1990.

FAO (Food and Agriculture Organization of the United Nations), *An Interim Report on the State of the Forest Resources in the Developing Countries*, Rome, Italy, 1988.

Discussion Opening—*Catherine Halbrendt* (University of Delaware)

This paper by Liu and Lu addresses a very pressing situation; i.e., sustainable development in less-developed countries through appropriate land use. To generate discussion, I will organize my comments in two parts: (1) the strengths and weaknesses of the major sections of the paper, and (2) additional issues concerning sustainable development not mentioned in the paper.

The global land use trends shown by regions and countries were very illustrative. The authors showed, by regions, respective accelerating rates of conversion of forest land into agricultural land to meet increasing food demand driven by population growth, especially in Asia and South America. However, this section of the paper fails comprehensively to identify the causes of the relative accelerating rates of land use by country upon which policies are based. More descriptive statistics should have been presented to infer comparatively why, for example, India's rate of land conversion is higher than Indonesia's although they are both in the Asian continent. Quantifying hypothesized linkages such as accelerating population growth, low productivity per capita, or policy incentives to rates of conversion by country are necessary to formulate effective policy reforms.

More in-depth analysis by agricultural enterprise by country would have enhanced the paper. More literature reviews on the effects by agricultural enterprise by country would have provided substantial insights into the differential impacts of deforestation. A summary quantifying the effects of economic incentives, technological adoption rates on productivity changes, and soil erosion by agricultural enterprise and country would definitely help formulate more prototype policy programmes useful in promoting a global sustainable resource base.

The section on formulating a global agenda for a sustainable resource base was very comprehensive. However, I would have liked the authors to focus more on discussing unique recommendations targeted towards sustainable development differentiated by a country's stage of development and resource endowments, as they undoubtedly require different policy recommendations.

The paper is useful as it addresses an important issue and proposes a useful agenda for decision makers, but, for practical purposes, it needs to be more focused and the analysis more comprehensive, such as including other very necessary elements essential for sustainable development; i.e., the socio-political sustainability aspects. Effectiveness of any sustainable land-use programme is highly dependent on whether social and economic policies established concurrently are politically sustainable.

[Other discussion of this paper and the authors' reply appear on the following page.]

General Discussion—*Daniel Pick, Rapporteur* (US Department of Agriculture)

One discussant felt that demographic factors behind deforestation were given much attention while demand-driven factors were ignored. He further commented that in dealing with natural forests, applying economic efficiency criteria is very complicated.

Knerr, in reply, agreed that the use of forest land and deforestation is not always negative. Yet, the negative effects are shifted to future generations who will have to pay for it. She further agreed that other nations that have vested interests in retaining the forests may have to pay for doing so. She warned that, for some countries, establishment of property rights will not be a good solution to deforestation, as small owners will continue to exploit the land, disregarding future generations.

A further point raised was that soil erosion is more than just an outcome of overcultivation, and no mention was made of water's contribution to the problem.

Lu, in reply, acknowledged that more research on specific countries is needed as well as research on the effects of deforestation on soil erosion. He further acknowledged that political and social stability were not included in their analysis.

Participants in the discussion included N.I. Isaksson (Swedish University of Agricultural Sciences), G.T. Jones (University of Oxford), F.G. Mack (Inter-American Development Bank), and N. Shanmugaratnam (Agricultural University of Norway).