Croplands

THE WORLD has doubled food production in the past 35 years, more than keeping pace with population growth. This has largely been made possible by new crop varieties, increased chemical inputs to fields and the extension of land under irrigation. But it is questionable whether we can continue to increase output as populations rise.

Of the world's agricultural land, only around a third is used to grow crops, with the remaining two thirds dedicated to livestock pasture. In recent decades, for the first time in history, increased yields have been achieved largely through intensified farming, rather than by extending the tilled land. Sustained by chemical fertilizers, pesticides, irrigation and mechanization, the use of a few high-yield crop varieties has developed and spread, contributing to an enterprise known generically as the "green revolution". This has also, of course, been driven by demographics – the demand of more mouths to feed and, in the developing world, more people working in the fields.

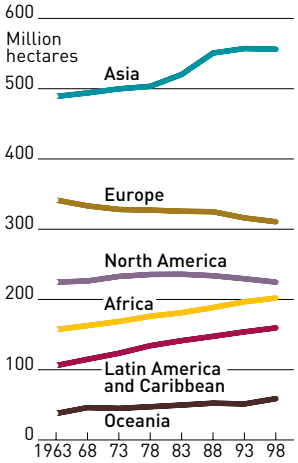
The green revolution has modified natural ecosystems into a highly simplified and nutrient-rich state. A handful of plants, bred into entirely new strains, have become the dominant plants on the planet. The four main grain crops – wheat, rice, maize and barley – occupy a total of some 500 million hectares[1], mostly in those countries with the highest populations. The green revolution was not all good, however. It spread a farming method that relies heavily on chemical fertilizers, monocultural cropping practices and decreased fallow times, coupled with more intensive plowing. Local water supplies became degraded and crop diversity decreased, leading to land degradation and erosion. Concern has increased over the implications of pests that thrive on now dominant strains of grain and maize.

Chemical applications to fields have soared. The doubling of agricultural production during the past 35 years has required a 600 percent increase in nitrogen fertilizer and a 250 percent increase in phosphate fertilizer. This has been accompanied, over the same period, by a 70 percent increase in irrigated cropland, but only a 10 percent increase in the area of cultivated land[2]. One immediate effect of such high fertilizer use is that human activity has taken over from nature as the dominant source of fixed nitrogen in the environment. Natural sources from soil bacteria, algae and lightning release 140 million tons of fixed nitrogen a year; human sources now total 210 million tons per year, of which 86 percent comes from agricultural activity, with fertilizer responsible for most of it[3].

More than half of all the commercial fertilizer ever produced has been applied to fields since 1984. However, largely because of widespread overuse, a half of that application never reached plant tissue, but evaporated or washed into rivers. The result has been a nitrogen overload of natural ecosystems, particularly in Western Europe and East Asia, where average annual applications on arable land are highest[4]. Application rates generally reflect wealth or the pressure in densely populated countries to raise food production.

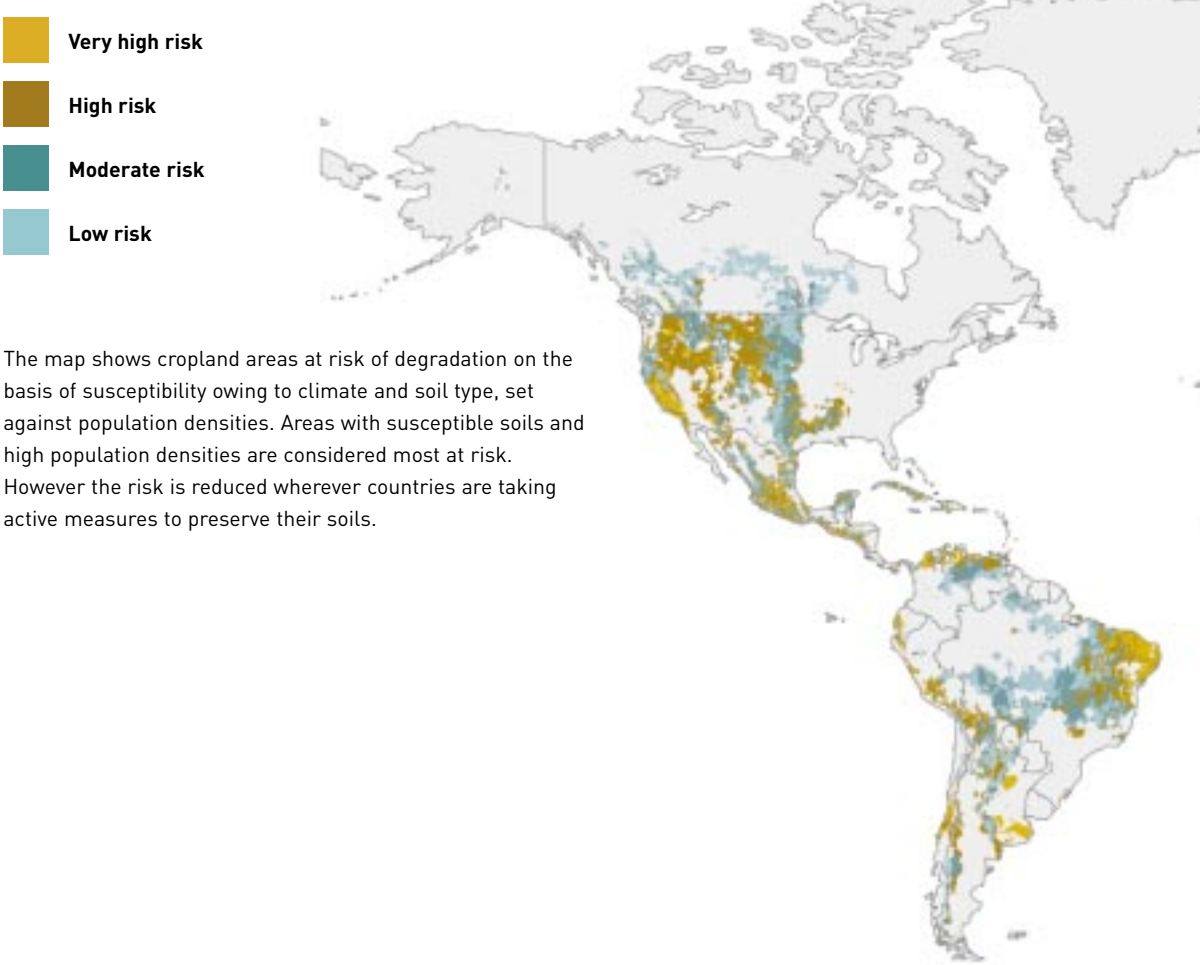
Changes caused by nitrogen overload range from the seemingly harmless, such as the spread of nettles in English hedgerows, to toxic algal blooms in lakes, rivers and coastal waters, resulting

WORLD ARABLE AND CROPLAND By region



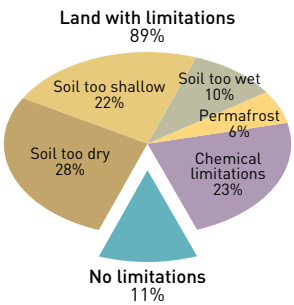
Source: FAO.

CROPLANDS AT RISK OF DEGRADATION, 1999



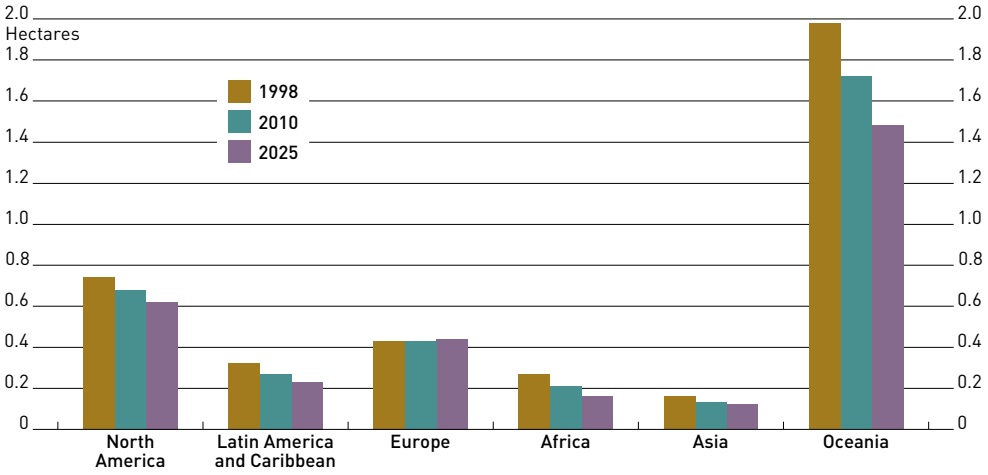
The map shows cropland areas at risk of degradation on the basis of susceptibility owing to climate and soil type, set against population densities. Areas with susceptible soils and high population densities are considered most at risk. However the risk is reduced wherever countries are taking active measures to preserve their soils.

GLOBAL SOIL LIMITATIONS TO AGRICULTURE

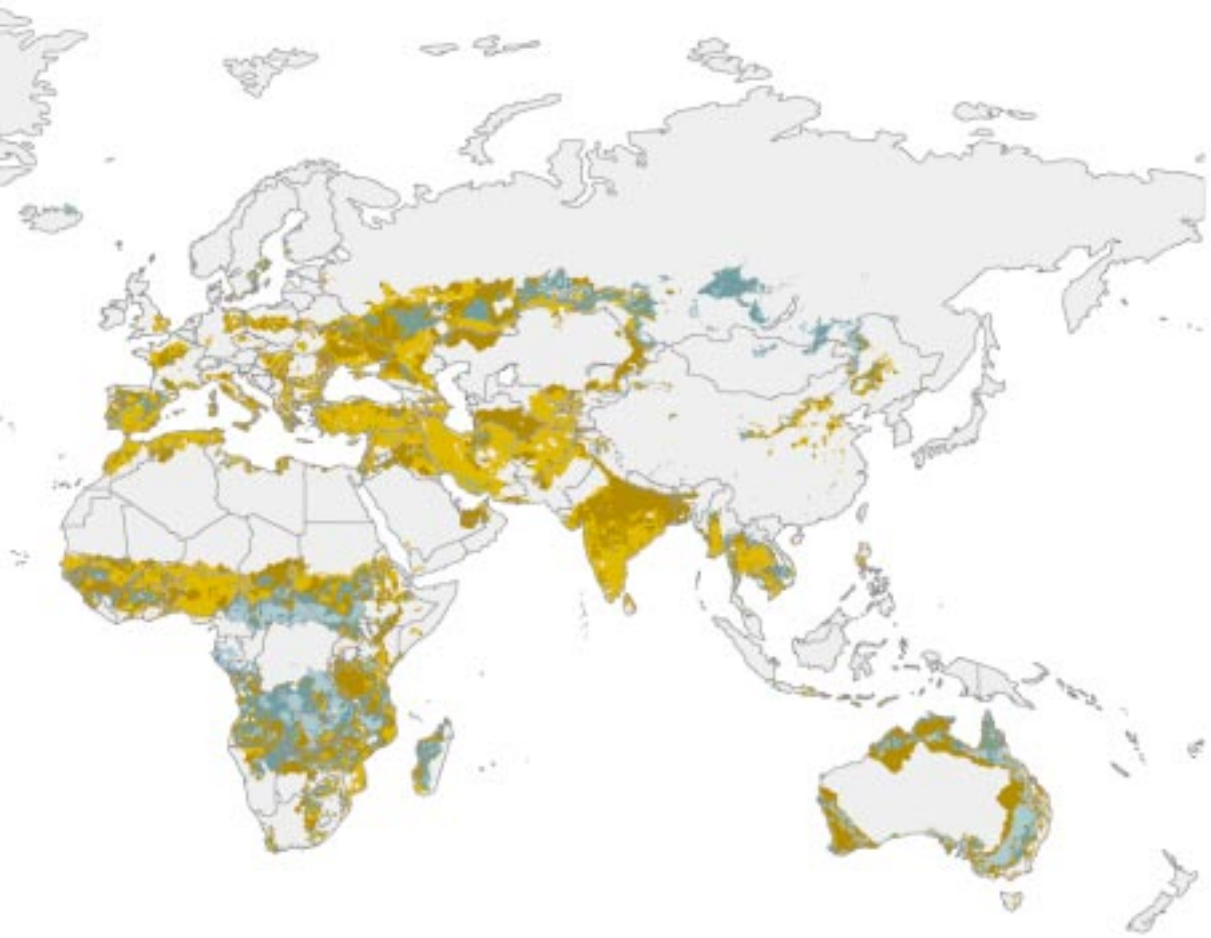


Source: FAO.

ARABLE LAND PER CAPITA, BY REGION Current and projected



Source: FAO; UNPD.



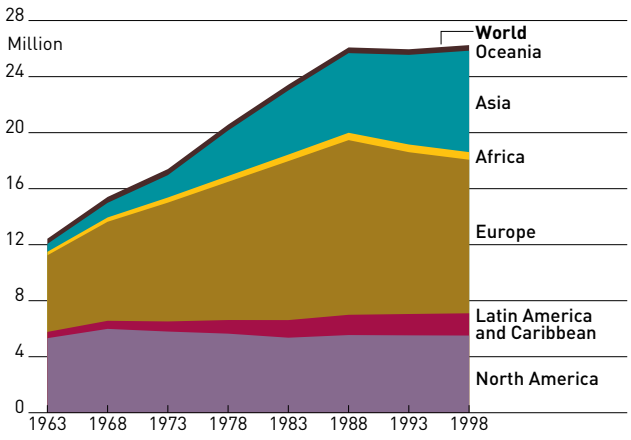
Source: WSP-USDA.

TRACTORS: AN INDICATOR OF MECHANIZATION

Tractors in use, 1998, selected countries

	Tractors per thousand agricultural workers
USA	777
France	641
Japan	436
Spain	282
Libya	102
Argentina	69
Russia	56
Korea, Rep.	38
Chile	23
Iran	12
Botswana	8
Pakistan	4
Zimbabwe	3
Vietnam	2
Kenya	Less than 1

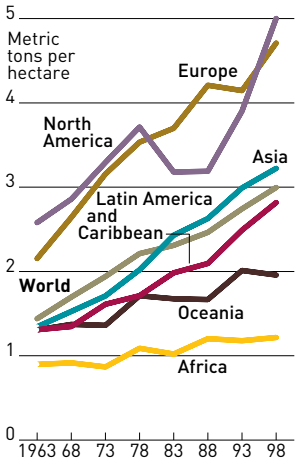
Increases in tractor use



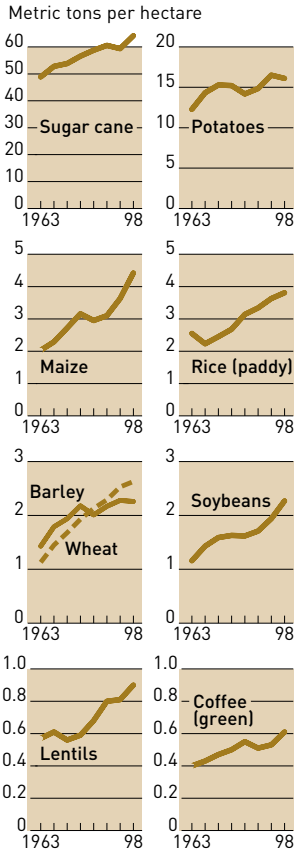
Source: FAO.

WORLD CROP YIELDS

Cereals, by region



World average for selected crops



Source: FAO.

SHARE OF AREA PLANTED TO MODERN CROP VARIETIES IN DEVELOPING COUNTRIES (%)

	Rice+		
	1970	1983	1991
Developing countries	30	59	74
Sub-Saharan Africa	4	15	id
West Asia and North Africa	0	11	id
Asia*	12	48	67
China	77	95	100
Latin America	4	28	58

	Wheat+		
	1970	1983	1990
Developing countries	20*	59*	70
Sub-Saharan Africa	5	32	52
West Asia and North Africa	5	31	42
Asia*	42	79	88
China	id	id	70
Latin America	11	68	82

	Maize
	1990
Developing countries	57
Sub-Saharan Africa	43
West Asia and North Africa	53
Asia*	45
China	90
Latin America	46

+ Excluding tall varieties released since 1965. If these varieties are included, the area under modern varieties increases, especially for rice in Latin America
* Excluding China

Source: FAO.

from a process called eutrophication, and the leaching of key nutrients such as calcium and magnesium from soils[5]. In addition, nitrogen evaporation from soils (along with methane emissions from rice paddies) is contributing to global emissions of greenhouse gases.

Worldwide pesticide use has also soared, reaching 5 million tons annually[6]. Three quarters of pesticides, predominantly herbicides, are applied in Europe, North America and Japan, where farmers can most easily afford them. In tropical developing countries the greatest need is for the more toxic broad-spectrum insecticides, largely applied to export crops such as cotton, bananas and coffee. In such export crop plantations, acute pesticide poisoning can affect 10 percent of the workforce[7]. But the pesticide poison cycle reaches further. Pesticides evaporate into the atmosphere at the point of use and circulate the planet, eventually distilling out in the chill air of the Arctic where they poison polar bears, whales and even humans.

Hectare for hectare, most irrigated land is more productive than rainfed land, and in some regions, such as the Nile delta and the Sind in Pakistan, it is essential to crop production. The amount of irrigated land worldwide has tripled since 1950 to cover 270 million hectares, accounting for more than a third of the global harvest[8]. Most of this is in densely populated regions of Asia, where it allows two or three crops a year, and in the Middle East, where without it there would be virtually no agriculture. In many parts of the world, countries are reaching absolute limits of the availability of water (much as they did with farmable land 40 years ago) and must improve the efficiency of its use if they are to raise production.

Increases in large stands of monoculture crops have had important ecological consequences. With this type of cultivation the range of plant pests becomes less diverse, but more abundant, reflecting the plants themselves. Organic matter in the soil is lost, altering the soil biota and generally involving a loss of soil fertility. These changes increase the need for pesticides and fertilizers and, combined with the physical impacts of erosion, cause soil degradation.

Croplands tilled and then left without the protective cover of vegetation are particularly vulnerable to soil loss through wind and water erosion. Worldwide an estimated 12 million hectares of croplands fall out of use for this reason each year. Economists have estimated the value of this lost soil, in terms of nutrients and water-holding capacity, at about US$400 billion a year[9]. Erosion rates are highest in Asia, Africa and South America, estimated at typically 30 or 40 tons per hectare annually, while about half that amount is being lost in Europe and North America[10]. The high rates reflect poor land management, poverty and the cultivation of marginal and sloping land, as well as population density and the resulting pressure to cut fallow periods and grow several crops a year. Land is also degraded by salinization – generally as a result of the waterlogging of irrigated land, which can bring salts to the surface, forming a white crust toxic to most plants.

The rate of soil degradation raises questions about the long-term sustainability of yield increases without a rising tide of inputs[11], while concern for sustainability has increased interest in new methods of farming, based on lower inputs and greater attention to ecological principles using local knowledge and natural biological means of pest control[12].

Typical methods include using organic fertilizer from farm animals and planting leguminous crops to fix nitrogen in the soil, growing plants that repel pests, protecting soils by terracing and reducing tillage, and harvesting rainwater in arid regions.