Sustainable Agriculture - Its Role in Food Security

J. Nösberger

Institute of Plant Sciences, ETHZ, 8092, Zurich, Switzerland

Abstract : *The challenge of agriculture continues to be one of balancing food security demands with population growth, and tremendous pressure on natural resources. Global food production must increase by 2 percent or more per year. The prevailing conditions for food security efforts are constantly changing. Socio-economic factors are prioritised, the biophysical factors and the ongoing changes in the natural resources are not adequately considered. We must commit to the goal of no net increase in cropped area, and expect a decline in natural fertility of agricultural soils. Water will become a severely limiting growth factor; the groundwater depletion could be a major threat to food security. Due to climate change, the crop plants will probably experience more environmental stress. Low rates of yield gain are evident in different countries and must raise concern. The developing world is facing an unprecedented change too much more animal protein based human diets.*

The role of agriculture in providing food security is discussed in the context of modern farming.

Introduction

Global agriculture is facing many demands. It must provide food, fibre, industrial products and ecosystem services. The challenge continues to be one of balancing food security demands with population growth, and tremendous pressure on natural resources. Regardless of whether we are optimists or pessimists on production needs, global food production must increase by 2 percent or more per year. Increasing farm productivity by this magnitude in a sustainable way will require the development and application of new and the adaptation of proven technologies for research and extension. The conformation to nature and protection of environment as aspired by the Kyusei Nature Farming is helping to achieve this goal. Sustainable systems must satisfy three criteria: (1) preserve natural resources; (2) be economically acceptable; and (3) be socially acceptable. There is reason for concern regarding these pillars of sustainability. Ongoing changes in the agricultural research system with a decreasing public support are accompanied with processes that have a great negative potential impact on the well being of humanity and the preservation of natural resources. We are faced from an agricultural perspective with several driving forces that are requiring solutions: (1) the growing global population; (2) decreasing availability of land and increasing soil degradation; (3) increasing water scarcity; (4) expected climate change; and (5) changes in yield growth rate and in the human diet.

Estimates and Projections of Hunger

If we do not put the human population at the core of the sustainable development agenda, our efforts to improve human well-being and preserve the quality of the environment will fail. World population reached 6.1 billion in mid - 2000 and is currently growing at an annual rate of 1.2 per cent. By 2050, world population is expected to be between 7.9 billion (low variant) and 10.9 billion (high variant), with the medium variant producing 9.3 billion. Latest estimates indicate that roughly 800 million people, with a high percentage of young persons, are undernourished. Economies will fail to grow rapidly or equitably as a result. A chronically undernourished person has diminished physical and cognitive abilities, leading to decreased productivity. A society of undernourished people cannot progress.

At the World Food Summit of 1996, the global community agreed to halve the number of hungry people in the world by 2015. To reach this target 22 million people need to escape hunger each year. Only 6 million have been fortunate enough to do so each year. The Food and Agriculture Organisation of the United Nations are assuming that with the policies and approaches now being pursued in most countries, that sustainable food security for all will be met not by 2015, but by 2050.

The prevailing conditions for food security efforts are constantly changing. Actual discussions are focussing on the socio-economic and political aspects: good governance, globalisation, alleviation of poverty, health and nutrition crisis, urbanisation and sweeping of new technologies. However, the prioritising of these certainly critical factors is not considering adequately the biophysical potential and the ongoing changes in the natural resources needed to produce more food. Extrapolations from the past are based on assumptions, which may not be valid for the future.

Trends in the Area of Cultivated Land

The area of land suitable for cropping but still unused is still significant in southern Africa and the Americas, but suitable unused land is already scarce in Asia and East Africa (Penning de Vries 2001). Building of roads and infrastructure often occurs at the expense of cultivated land. Housing, roads and other infrastructures requires approximately 0.025 ha per capitata (1998), this fraction is rising; and for extrapolation into the future, an annual loss of 0.1% is used (Penning de Vries 2001). Moreover, agricultural land can become degraded completely and irreversibly by various processes, including soil erosion, nutrient mining, salinisation and pollution. A conservative estimate assumes that globally 0.5% of agricultural land per year is degraded (Penning de Vries 2001) in developing countries already 16% of all agricultural land is seriously degraded (Scherr 1999). Crops on this land can no longer be grown profitably and restoration is economically not realistic. Since land resources and populations are very unevenly spread, therefore, resource poor farmers in some countries are already cultivating marginal lands. There is a great risk that some of this land will be degraded completely. Consequently, in the next 30 years, crop scientists must commit to the goal of no net increase in cropped area (Cassman 2001).

Not sustainable agricultural practices are one of the main reasons for this serious loss of land by degradation. One indicator of soil condition- and productive capacity- is soil nutrient balance. The most common management techniques used to maintain fertility of agroecosystems is the application of manure or inorganic fertilisers (nitrogen, phosphorus and potassium). Too little can lead to soil nutrient mining (amount of nutrients extracted by harvested crops is greater than the amount of nutrients applied), and too much can lead to nutrient leaching and the contamination of ground and surface waters. Nitrogen is the most limiting plant nutrient. The symbiotic nitrogen fixation a green way to higher soil fertility is not sufficiently used. More legumes should be included in cropping systems. Researchers from the Pilot Analysis of the Global Ecosystems (PAGE, using satellite-derived data, digital maps, and new ways of mapping global agriculture) have overlaid maps of nutrient balance with trends in yield to identify potential degradation areas, where yield growth is slowing and soil fertility is declining. These areas where the capacity of ecosystems to continue producing food using current production methods appear most threatened, include Central America, northeast Brazil, sections of Argentina, Bolivia, Colombia, Paraguay, Sub-Saharan Africa, China, South and Southeast Asia (World Resources Institute 2000). The trends of declining natural fertility of agricultural soils and the demand for soil for infrastructure are disturbing trends. The excessive mining of soils, pollution of water and its wastage in major irrigation schemes, and lack of preserving soil organic matter have all led in many cases to the loss of sustainability (Sangakkara 2001). This situation requires integrated solutions that are beyond soil and crop science.

Increasing Competition for the Scarce Water

Agriculture consumes 70 per cent of the freshwater withdrawn annually by humans. Irrigation is draining more water than is being replenished by rainfall, causing water tables to fall. Moreover, many water sources are being polluted by excessive use of fertilizers and pesticides. Sediment from erosion can greatly degrade surface water quality. Irrigated agriculture creates problems associated with excess water in the soil profile: waterlogging and salinisation. Both problems can decrease productivity and lead to abandonment of the affected land. In countries that rely heavily on irrigation ñ an average of 20 percent of irrigated land suffers from salinisation (UN Development Programme et al. 2000).

In a recent study by the International Water Management Institute (Seckler et al. 1998) it was estimated that nearly 1.4 billion people, a third of the population living in developing countries, live in regions that will experience severe water scarcity within the first quarter of this century. The single most serious problem in the entire field of water resources management is the problem of groundwater depletion. Many of the most populous countries of the world- China, India, Pakistan, Mexico and nearly all countries of the Middle East and North Africa- have literally been having a free ride over the past two or three decades by depleting their groundwater resources (Seckler, et al. 1999). These regions contain some of the major breadbaskets of the world such as the Punjab and the North China Plain. In addition, there is an increasing competition for water from other sectors. This situation poses a tremendous challenge for policy makers and agriculture, especially in developing countries where urban populations and the industrial sector are growing quickly. These circumstances poses several challenges for agricultural research (Turner 2001): e.g. (1) To apply modern breeding technologies to improve the yields and drought resistance of crops, especially minor crops grown by resource-poor farmers, under marginal water-limited environments. (2) To develop productive deep-rooted, short-term perennial crops that can utilize rainfall outside the main growing season(s). It is clear, the increasing world population, coupled with land and water scarcity, will put increasing demands on agricultural scientists, to increase crop yields in marginal environments in which abiotic stresses, particularly water deficits prevail.

Expected Climate Change

The world’s climate changed during the twentieth century and is continuing to do so. At least part of this change is caused by anthropogenic emissions of greenhouse gases (carbon dioxide, methane, nitrous oxide) and sulphate aerosols according to the latest report of the Intergovernmental Panel on Climate Change (Houghton & Yihui 2001). Carbon dioxide emission has increased dramatically since the begin of the industrial age by burning of fossil fuels and changes in land use systems (intensification, land clearing). The response of the plants and of whole ecosystems to the rising carbon dioxide concentration in the air is central to the problems associated with climate change. The effect of rising CO_2 concentration on ecosystems is investigated intensively. We can safely conclude that in most systems, photosynthesis is increased in a CO_2 rich world, and this generally results in increased plant growth. It is more difficult to make general statements about whole-system responses, such as carbon storage in the soil, water yield, species composition and crop yield. The magnitude of the yield response to the increase in CO_2 varies with the functional type of plant and with the soil nitrogen and water status (Kimball, et al. 2002). The response of grassland ecosystems is more complex, over time the ecosystem may adapt to the increased atmospheric CO_2 concentrations, and a new equilibrium may be established in the fluxes of carbon and nitrogen (Daepp et al. 2000).

Evidence accumulated by the Intergovernmental Panel on Climate Change (IPCC) showed that a significant anthropogenic contribution is required to account for the observed climatic trends over at least the last thirty years (Houghton &Yihui. 2001). New studies report evidence that increases our confidence in models, which are describing observed and projected changes in extreme rainfall and flooding (Schnur 2002). These studies predict that the risk of extreme rainfall over Europe and Asian monsoon regions is increasing. It is very likely that daytime maximum and minimum temperatures will increase. Therefore, the crop plants will probably experience more stressful growing conditions. Sustainable agricultural systems can contribute to mitigate the problems associated with climate change. Significant reduction of greenhouse gas emissions can be achieved through changes in agricultural practices, such as: (1) Soil carbon uptake enhancement through conservation tillage and reduction of land use intensity, (2) Methane reduction by rice paddy irrigation management, improved fertilizer use, and lower enteric methane emissions from ruminant animals (Metz & Davidson 2001)

Changes in Yield Growth Rate and in the Human Diet

Projections made by the IMPACT model developed by the International Food Policy Research Institute (IFPRI) to simulate future global food demand and supply, suggest little difficulty in achieving food security. This prediction depends in large part on productivity trends of a few major cropping systems in favourable environments, while local and regional food security depend on substantial improvements in productivity of cropping systems in less favourable environments, especially in developing countries. In addition, econometric studies express yield trends as exponential rates of gain, it is notable that yield trends for the major cereals are decidedly linear (Cassman 2001) Hence, the rate of gain on a percentage basis decreases with time. Moreover, variation in rates of yield gain is evident in different countries and must raise concern. We must provide more accurate estimates of the biophysical constraints to crop productivity and more investment in research and extension is required to alleviate them.

Reflections on food security do often not appropriately consider the ongoing livestock revolution (Delgado et al. 1999). The developing world is facing an unprecedented change to much more animal protein based human diets. FAO is expecting that the per capita meat production in the developing countries will increase by nearly 50% between 2000 and 2020. This expanding production is exerting increased pressures on natural resources. Policy and research must emphasise the role of range and grassland systems in soil conservation, as habitat for livestock and wildlife, and as refugia for biodiversity.

With good husbandry, low-input grassland systems can meet the multipurpose goal of natural resource conservation, preservation of wildlife and plant biodiversity, and livestock production at low, but sustainable levels of productivity.

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