Feeding the World
Sustainable Management of Natural Resources

April 2008

I. Introduction

At the 1996 World Food Summit (WFS), leaders from 186 countries pledged to reduce the number of hungry people in the world by half no later than the year 2015. Goal 1 of the Millennium Development Goals specifically sets out to both reduce by half the proportion of people living on less than a dollar a day and to reduce by half the proportion of people who suffer from hunger by 2015.

Between 1960 and 2000, the world's population doubled, yet levels of human nutrition improved markedly. World agriculture has been successful in producing ever greater quantities of food, enabling massive strides in improving food security. The proportion of people living in developing countries with average food intakes below 2 200 kcal per day fell from 57 percent in 1964-1966 to just 10 percent in 1997-1999. Concurrently, the prices of the world's major food staples (rice, wheat and maize) fell by around 60 percent, indicating that, at the global level, food supplies not only kept pace with, but outstripped, demand.

Yet today hunger still strikes more than 840 million people across the globe – sapping strength and dulling intelligence, it destroys innocent lives, especially those of children. By weakening a nation's workforce, hunger cripples national growth. It is an issue not just of production but of availability and access to food which are limited by poverty, by inadequate investment in rural areas, in marketing, processing, storage and transport and by urbanization which means increased populations unable to satisfy their own subsistence. Moreover, global food and feed prices have suddenly escalated and become much more volatile (2005-2008) – the FAO food price index rose on average 9 percent in 2006 and 23 percent (compared to 2006) in 2007, due to a combination of factors including weather-related production shortfalls, the gradual reduction in levels of stock (since the mid-1990s), increased fuel costs, changes in

the structure of demand and the surge in interest in biofuels.

Despite impressive reductions in the proportion of undernourished, continuing population growth means that progress in reducing the total number will be slower. The World Food Summit of 1996 set a target of halving the number of undernourished people to approximately 410 million by 2015. FAO projections suggest that this may be difficult to achieve: some 610 million people could still be undernourished in that year; even by 2030 about 440 million undernourished may remain.

There has been global stagnation in hunger reduction, which masks significant disparities among regions: Asia and the Pacific and Latin America and the Caribbean have seen an overall reduction in both the number and prevalence of undernourished people since the WFS baseline period. The regions which are falling behind in meeting MDG-1 are sub-Saharan Africa and South Asia.

The achievement MDG-1 will depend upon development in rural areas, which are likely to remain the nucleus of world hunger and to contain the majority (51 percent) of the developing world's population beyond 2015. The engine of agriculture has proved uniquely powerful in the past to help people escape poverty and hunger – it should again be put at the centre of the development agenda in the twenty-first century, with a new, innovative green revolution for sustainable development, including poverty reduction and sustainable use of resources and ecosystems.

Agricultural ecosystems are by far the largest managed ecosystems in the world. Modern agriculture has been very successful in providing the ecosystem services for which markets exist – crops, livestock, fish and forest products – in ever greater quantities. But this

expansion has often been achieved at a high environmental cost. The impacts of many agricultural practices (*inter alia* deforestation for conventional agriculture, extensive grazing, nutrient depletion, decline in vegetation cover or diversity are found across all agricultural systems.

Attainment of MDG-7 (environmental sustainability) requires the realization of sustainable agriculture systems. There is now inexorable pressure on world agriculture to play a much wider range of roles than ever before. While guaranteeing food security for the global population and a source of livelihood for billions of people, particularly the poor, it must also provide sustainable ecosystem services to the wider environment (supplying drinking water, maintaining a stock of continuously evolving genetic resources, preserving and regenerating soils, fixing nitrogen and carbon, controlling floods, filtering pollutants, pollinating crops and much more).

II. Overcoming hunger, poverty and environmental degradation

Agricultural production, consumption and the natural resource base

At present, FAO studies show that about 5 billion ha of the globe's total (13.4 billion ha) is used in agriculture (source: FAO Statistics Division, 2001-2003). 3.5 billion ha are under pasture, 1.4 billion ha under arable and 138 million ha under permanent crops. The cropped areas represents slightly over a third (36 percent) of the land estimated to be even partially suitable for crop production.

The annual growth rate of world demand for cereals has declined from 2.5 percent a year in the 1970s and 1.9 percent a year in the 1980s to only one percent a year in the 1990s. Annual cereal use per person (including animal feeds) peaked in the mid-1980s at 334 kg and has since fallen to 317 kg as a result of shifts in human diets and animal feeds.

In developing countries overall, cereal production is not expected to keep pace with demand. The net cereal deficits of these countries, which amounted to 103 million tonnes or 9 percent of consumption in 1997-1999, could rise to 265 million tonnes by 2030, when they will be 14 percent of consumption. This gap can be bridged by conversion of pasture to cropping, reduction in fallows) increases the vulnerability of land to degradation; wind and water erosion, salinization, soil compaction and sealing,

increased surpluses from traditional grain exporters and by new exports from countries in transition, which are expected to shift from being net importers to being net exporters.

With increasing urbanization (over half the world's population is urban in 2008) diets are changing, particularly in the rapidly growing urban centres of developing countries. Diets are generally becoming similar to those in developed countries – with the share of staples (cereals, roots and tubers) declining, while that of meat, dairy products and oil crops is rising. However, cereals remain by far the world's most important sources of food, both for direct human consumption and indirectly, as inputs to livestock production.

Livestock production currently accounts for some 40 percent of the gross value of world agricultural production, a share that is rising. It is the world's largest user of agricultural land, directly as pasture and indirectly through the production of fodder crops and other feedstuffs. Livestock provide not only meat, but dairy products, eggs, wool, hides and other goods. They can be closely integrated into mixed farming systems as consumers of crop by-products and sources of organic fertilizer, while larger animals also provide power for ploughing and transport.

In most developing countries, livestock production and productivity growth is low and has not been sufficient to keep up with the demand of expanding populations. In 2006, Africa had 17.4 percent of world population of cattle (234 m head) but accounted for only 4.4 percent of world production of meat (12.4 million tons) and 5.5 percent of world production of milk (33.3 million tons); entailing increased levels of imports of livestock products, currently valued at close to US$2.3 billion per year and projected to further increase. In order to keep pace with human population growth, the output of livestock products in Africa would have to increase by at least 2.7 percent annually.

At the moment, most extensive and intensive agriculture systems have large environmental footprints. On less-favoured areas, extensive agricultural systems have for a range of reasons suffered from mismanagement, frequently leading to soil erosion, deforestation,

degradation of pastures and watersheds. In particular, in medium to high potential areas, intensification has led to reductions in biodiversity and agrobiodiversity, mismanagement of water (particularly through irrigation), also pollution by fertilizers, pesticides and animal wastes. However, clear opportunities exist to reduce the environmentally damaging effects of agriculture.

Sustainable agriculture for rural development to reduce of hunger and rural poverty

Today, sustainable agriculture is once more being recognized as the fundamental catalyst for development. It can contribute to reductions in both hunger and poverty through increasing the assets of the poor households, increasing productivity and creating opportunities in the rural non-farm economy.

In the past, agriculture has been the basis for growth and poverty reduction in many countries – for example in the 1970s and 1980s in Asia during the "green revolution". Yet since then, "**agriculture has been underused for development**" (World Bank, 2007). The pressures of recurrent food crises have tilted national budgets and donor priorities towards provision of food rather than investing in agricultural growth and achieving food security. Rapid population growth, diminishing farm sizes, declining soil fertility and missed opportunities for income diversification have concealed the potential of sustainable agriculture as an engine for growth.

The future of agriculture in both subsistence and commercial systems is intrinsically linked to stewardship of the natural resource base. Nutrients can be better managed through integrated nutrient management systems to optimize use of mineral fertilizers and reduce damage to water supplies by leaching of nitrates and other chemicals Alternatives exist to the widespread use nitrogen based fertilizers that emit noxious greenhouse gases, including use of leguminous crops in rotations and conservation agriculture. Methane releases from livestock waste can be managed to provide biogas. Soils depleted of organic carbon due to inappropriate cultivation regimes can be restored through no or reduced tillage, improved rotations and protective soil cover (mulch or fallows). Forests can be sustainably managed and carbon sequestrating woodlots created for sustainable household energy supplies, as an alternative to deforestation. Soil and water resources can be managed effectively through sustainable and biodiverse agro-ecosystems and watershed management.

Many more countries could benefit from development through the engine of agriculture, provided governments and international development partners reversed years of policy neglect, underinvestment and ill-advised investment, as agriculture uniquely contributes to development as an economic activity and livelihood, also as a provider of a range of environmental services. The answer is not to slow agricultural development but to ensure that only sustainable solutions are adopted – sustainable intensification through managed inputs, restoring resilient, integrated agro-ecosystems.

These developments will stimulate rural development, the processes that promote the livelihoods and well being of rural people, also the environmental, economic, social, cultural, institutional and political conditions of the countryside which are crucial to fighting global poverty and hunger. The attainment of the Millennium Development Goals (MDGs), especially Goal 1, depends upon this sustainable rural development, because the poor and hungry are concentrated in rural areas. Rural areas of the developing world contain only 45 percent of the total world population, but 80 percent of the world's hungry and 75 percent (900 million) of the world's poor (the 1.2 billion people who lived on less than US$1 a day in 2001).

Rural enterprise development is being recognized as a source of economic salvation amongst poorer households, providing them opportunities for economic growth and employment generation. Most entrepreneurial activities in rural areas are based on agricultural and natural resource products, thus farm families can broaden their income opportunities by diversification into higher value enterprises (both on- and off-farm). FAO is helping to enhance small farmer income and livelihoods, by reinforcing the commercialization of smallholder agriculture for sustainable economic growth and poverty

reduction; strengthening partnerships, providing policy advice and technical assistance related to market-oriented farming, also small and medium scale rural enterprise development.

Alone, agriculture will not be sufficient to massively reduce poverty, but it has proved to be uniquely powerful for that task – and indeed, massive reductions in poverty are unlikely without sustainable agricultural development. Agriculture can work in conjunction with other sectors to produce faster growth, reduce poverty and sustain the environment.

Sustainable intensification through managed inputs and resilient, integrated agro-ecosystems

Sustainable intensification of the wide range of agricultural systems is fundamental to reducing hunger and rural poverty. Across much of the developing world, yield growth will continue to be the dominant factor underlying achieving increases in crop production in the future. Overall, it is estimated that about 80 percent of future increases in crop production in developing countries will have to come from intensification: higher crop yields through appropriate use of fertilizers, improved germplasm and water management, increased multiple cropping and shorter fallow periods, improved land and livestock husbandry and pest and disease management. The share due to intensification will reach 90 percent and higher in the land-scarce regions of the Near East/North Africa and South Asia. Expansion of arable land will remain an important factor in crop production growth in many countries of sub-Saharan Africa and Latin America.

The enhancement and rehabilitation of land resources, including the improvement of widespread productivity decline, requires a multifaceted approach to improve crop and soil management in rainfed and irrigated systems. Progress can be made through more efficient management of soil, its water and biological processes; reducing soil run-off and erosion by increasing infiltration of rainwater, restoring soil biological activity and increasing soil's capacity to store plant nutrients.

Conservation agriculture (CA) is based on the principles of restoring the natural biological, chemical and physical processes above and below ground. Under CA, soil tillage is reduced to a minimum, external inputs (agrochemicals, mineral and organic nutrients) are applied at optimum levels to avoid interfering with biological processes, and soil organic cover (mulch or crop) is maintained to protect the surface from often intense tropical rain, sun and also the wind. Beneficial crop rotations are introduced/restored, allowing for biological control of pests and diseases and maintenance of soil fertility. CA makes some use of herbicides for weed control, but this is optimized and minimized. One of the net effects of CA is to promote the build-up of soil organic matter, depleted in many soils – enhancing infiltration and storage of rainwater (contributing to adaptation to climate change), also retaining plant nutrients.

CA holds considerable potential for all sizes of farms and agro-ecological systems, but its adoption is perhaps most urgently required by smallholder farmers, especially those facing acute labour shortages. It provides a truly sustainable production system, within which yields tend to increase over the years and inter-year yield variations decrease. No till fields act as a sink for CO_2, thus CA contributes to carbon sequestration – contributing to climate change mitigation. CA farmers can save between 30 and 40 percent of time, labour and in mechanized agriculture also fossil fuels, compared to conventional cropping. FAO is helping member countries to introduce and adapt CA systems that were developed and widely adopted over the last two decades by small- to large-scale farmers in Latin America, North America, Australasia and Central Asia, for smallholder and commercial farmers in Africa, South and Southeast Asia and the Near East.

Fertilizer consumption to support efficient food production is of primary interest to the world's farming communities. Given scarcities of suitable agricultural land in a number of developing countries, there is no escape from the necessity for a good part of the required production increases to come by extracting more output per ha cultivated − agriculture will become ever more intensive and fertilizer use will increase. However, more efficient use of fertilizer can be achieved, through improved timing, split applications, site-specific management, crop rotation and soil testing, facilitating higher yields with the same or even

less fertilizer; bringing direct economic benefits. These approaches will also contribute to balancing the use of fertilizers to increase yields with the environmental impacts of their production (which is energy intensive) and use (particularly if over-used, nitrogenous fertilizers produce large quantities of nitrous oxide, a powerful greenhouse gas).

Addressing the fertilizer challenge in the context of food security entails first creating effective demand for fertilizer. Increased demand relates primarily to fertilizer use profitability, which requires that farmers receive a larger share of the commodity value paid by consumers, generating farm incomes. Where possible, alternatives should be encouraged (use of nitrogen fixing legumes in rotations or organic composts), but in the face of widespread hunger, in many areas there are no alternatives to increase land productivity or overcome specific mineral deficiencies.

Various other approaches have been developed towards more integrated plant nutrition for sustainable agricultural intensification. Integrated Plant and Pest Management has evolved from a single-crop-pest focus to more comprehensive efforts that combine investigations into various production-related problems and includes a variety of focus areas ranging from integrated pest management to integrated plant nutrient management. The emphasis is on providing farmers with the skills required to grow healthy crops. Currently, soil fertility research and strategy focus on the new paradigm of Integrated Soil Fertility Management, which is a holistic approach in soil fertility research that embraces the full range of driving factors and consequences of soil degradation – biological, chemical, physical, social, economic, health, nutrition and political.

Many of these approaches include increasing soil carbon sequestration, which not only raises the soils' nutrient retention capacities, but brings additional benefits for farmers by reducing vulnerability to the impacts of climate change (increasing rainwater infiltration, water retention in the profile and promoting beneficial biological activity). It is important that such carbon sequestration in agricultural soils is included in the post-Kyoto climate agreement.

Issues of seed and germplasm are further crucial elements in the livelihoods of agricultural communities. Increasing access to better quality seed and germplasm is essential for any strategy for farming system intensification in developing countries. The seed sector of most developing countries is characterized by weak seed production and distribution systems, inadequate supply of quality seed, lack of access to improved germplasm, weak entrepreneurial capacity of small- and medium-size seed enterprises, and inadequate implementation of seed policies and international agreements and conventions.

FAO tackles the crucial issue of seeds at different levels. Support is provided at the national level on issues related to seed regulations, capacity building in seed quality production, support in the interaction between the public and private seed sectors and improving the complementarity between the formal and informal seed sectors, taking into consideration the national needs for local varieties and the national use of the Plant Genetic Resources for Food and Agriculture (PGRFA). National capacity building is provided for the efficient handling of genetically modified seeds and planting material and the support in national biosafety frameworks. At the global level, FAO acts as neutral forum for discussion on critical issues such as biosafety and the use of genetically modified organisms.

To address these problems and improve national capacities to better use PGRFA, in 2006 FAO launched the Global Partnership Initiative for Plant Breeding Capacity Building (GIPB), which is a comprehensive and multi-component global partnership initiative in plant breeding capacity building. The five objectives of this initiative are: (i) provision of policy support on plant breeding and associated biotechnology capacity building strategy to policy-makers in developing countries; (ii) provision of training and education in plant breeding and related biotechnology capacities relevant to utilization of plant genetic resources; (iii) facilitation of access to technologies in the form of tools, methodologies, know-how and facilities to finding genetic solutions to crop productivity constraints; (iv) facilitation of exchange of plant genetic material from public and private breeding programmes widening the genetic

and adaptability base of improved cultivars, and (v) sharing information focused on plant

breeding capacity building to deliver access to newly available knowledge to national policy-makers and breeders.

Irrigation is recognized as an ever more important component of sustainable intensification of agriculture to meet MDG-1 and the WFS target. In 1997-1999, irrigated land made up only about one-fifth of the total arable area in developing countries, but produced two-fifths of all crops and close to three-fifths of cereal production. To keep pace with the growing demand for food, higher agricultural production will depend essentially on investment in the control of water. There appears to be enough unused irrigable land to meet future needs. However, water resources will be a major factor constraining expansion in South Asia, which will be using 41 percent of its renewable freshwater resources by 2030, also in the Near East and North Africa, which will be using 58 percent. These regions will need to achieve greater efficiency in water use.

Today only 7 percent of Africa's arable land area is irrigated – with only 4 percent in sub-Saharan Africa (which uses less than 3 percent of its water resources). Given that a third of the population of sub-Saharan Africa is undernourished and that its current population of 700 million is expected to reach 1.2 billion in 2030, the opportunities to improve the livelihoods of rural communities through water control are clear.

From now to 2030, the irrigated area in 93 developing countries could grow by 0.6 percent a year. Such a rate of growth would lead to a 23 percent increase in irrigated area over this period (40 million hectares). When coupled with increased cropping intensity, the effective harvested irrigated area is expected to increase by much more: from 241 to 323 million hectares, a 34 percent increase. Such investment in irrigated agriculture is also required to respond to the uncertainties regarding water availability due to climate change.

The introduction of synthetic pesticides (insecticides, fungicides and herbicides) changed the outlook on pest control as part of agricultural intensification. Heavy reliance on such compounds developed from the 1940s. Pesticide use remains highest in developed countries but these markets are stagnating or

contracting, as environmental concerns have become overwhelming and programmes have been established to reduce pesticide use.

Indiscriminate use of pesticides has resulted in changes in plant protection strategies in developing countries. Since the mid-1960s, Integrated Pest Management (IPM) has been advocated by FAO as the preferred pest control strategy. IPM is the careful integration of a number of available pest control techniques that discourage the development of pest populations, keeping pesticides and other interventions to levels that are economically justified, safe for human health and the environment. IPM emphasizes the growth of a healthy crop with the least possible disruption of agro-ecosystems, thereby encouraging natural pest control mechanisms.

Appropriate and safe use of pesticides in agriculture can contribute to reducing field losses. However, national pesticide legislation is not widely enforced in many developing countries, due to lack of technical expertise and resources, consequently highly hazardous or sub-standard pesticide formulations are still widely sold. Furthermore, end users are often insufficiently trained and protected to ensure that pesticides can be handled with minimum risk. The result is the widespread, hazardous problem of contamination of soil and water resources by agrochemicals. Hundreds of millions of empty contaminated pesticide containers continue to be left in rural areas, recreational areas, also on streets and dump sites in rural towns with little or no attention to their safe disposal.

FAO has revised and updated the International Code of Conduct on the Distribution and Use of Pesticides, a voluntary code which is now the globally accepted standard for pesticide management for all public and private entities associated with the distribution and use of pesticides. The Code has significantly raised awareness of the potential problems associated with pesticide use; strengthening NGO and pesticide industry involvement in pesticide management; including guidelines on the prevention and management of obsolete pesticides and implementing successful Integrated Pest Management (IPM) programmes in developing countries.

Environmental changes, human and animal demography, changing pathogens and changes in farming practices, particularly livestock intensification, have been associated with the growing incidence of animal to human disease transmission. There are over 200 known zoonotic diseases with some of the most significant human diseases having originated in animals. Some recent cases of zoonoses include Severe Acute Respiratory Syndrome (SARS), Avian Influenza, and Bovine Spongiform Encephalopathy (BSE). To speed up emergency responses to avian influenza, also other animal and plant diseases, FAO and the World Organisation for Animal Health (OIE), inaugurated a crisis management centre in 2006 to provide around the clock surveillance, updates, monitoring, and emergency support related to disease outbreaks, plant pests, and food safety. This promises to be particularly valuable for combating transboundary and transcontinental disease outbreaks.

The role of plant and animal genetic resources in food security

Plant genetic resources for food and agriculture (PGRFA) are essential to a sustainable agriculture and food security.

Over human history, people have used some 10 000 plant species for food, yet today only 20 crops provide 90 percent of dietary energy and protein, with a mere three, wheat, rice and maize, providing more than half of the global plant-derived energy intake. However, PGRFA, including traditional varieties, modern cultivars, crop wild relatives and other wild plant species are increasingly being recognized as essential to sustainable agriculture and food security. PGRFA are the raw materials used in the production of new cultivars; reservoirs of genetic adaptability which act as a buffer against changes in environmental conditions including climate change, pest and diseases, economic pressures and market shifts. Although much diversity has been conserved in genebanks (*ex situ*), the erosion of crop diversity resources in the field (*in situ*) poses a severe threat to the world's food security in the long term.

At the global level, FAO is recognized as a main promoter of conservation, sustainable utilization use of PGRFA, through its role in the Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture (GPA) and the International Treaty on Plant Genetic Resources for Food and Agriculture (IT-PGRFA – for which FAO provides the Secretariat), which is in harmony with the Convention on Biological Diversity.

FAO implements the GPA, which was adopted by 150 countries in 1996 and is a policy and action framework aimed at filling in gaps, overcoming constraints and facing emergency situations with regard to plant genetic resources. GPA is based on the assumption that countries are fundamentally interdependent with respect to plant genetic resources for food and agriculture and that substantial international cooperation is necessary to meet the aims of the Plan.

FAO's policies on PGRFA are linked to the sustainable use of ecosystem services, i.e. crop and crop-associated biodiversity and management of pollinators in agriculture (pollination services are essential for orchard, horticultural and forage production, as well as the production of seed for many root and fibre crops, increasing outputs of 87 of the leading food crops worldwide).

Over the years, many different kinds of animals have been domesticated in different regions of the world for different reasons. Breeds have developed slowly over a long selection process taking many thousands of years, driven by both natural and human needs. Through the natural process, only those species, which could withstand a particular agro-ecological zone, survived. On the other hand, humans carefully selected species based on physical and production traits to meet their local needs and requirements. Today there are some 6 000 to 7 000 known breeds of domesticated animals spread all over the world. The careful process for selection of different traits is largely responsible for the difference in performance and appearance of the breed from its wild progenitor, as well as from other breeds of the species.

Intensification of livestock production has relied upon uniformity in the genetic composition of the livestock. For example, almost all the pigs reared under commercial farming systems in Europe and North America belong to two or three breeds. Organized poultry farming across the world relies on a few multinational companies who have developed a handful of breeds for their supply of stock.

As in the case of plants, the narrow genetic base of livestock farming systems poses many inherent dangers. The narrow base, carefully selected for a particular trait, may be completely unsuitable for the emerging problems of the future. These include diseases, climate change and the increased demand for diverse livestock products. Protection of the wide genetic base is vital for the continuation of productive livestock farming under the diverse and changing agro-ecological conditions in which most of the world's poor live, where livestock fulfil a range of roles.

Global agriculture may be on the verge of a major shift, as biotechnology could give a welcome boost to production. The new techniques of molecular analysis may deliver solutions where conventional breeding approaches have failed, therefore it could greatly assist the development of crop varieties able to thrive in the difficult environments where many of the world's poor live and farm. Some promising results have already been achieved in the development of varieties with complex traits such as resistance or tolerance to drought, soil salinity, insect pests and diseases, helping to reduce crop failures.

Biotechnology offers promise as a means of improving food security and reducing pressures on the environment, provided the perceived environmental threats from biotechnology itself are addressed. The widespread use of genetically modified varieties will depend on whether or not food safety and environmental concerns can be adequately addressed. Indeed, the spread of these varieties in the developed countries at least, has recently slowed somewhat in response to these concerns, which must be addressed through improved testing and safety protocols if progress is to resume.

FAO's efforts have focused on strengthening national policies, to make them more conducive to research and, particularly, to approaches that generate, adapt and adopt technologies, knowledge and skills which are responsive to the needs of farmers, fishers and forest users – including national biotechnology strategies. FAO is also providing documentation and disseminating knowledge on good practices in biotechnology for rural development. The *FAO-BioDeC database* gathers, stores, organizes and disseminates updated baseline information on the state-of-the-art of crop biotechnology products and techniques, in use or in the pipeline in developing countries.

Improve market access, diversification, also employment in agriculture and non-farm sector

Rural infrastructure and support services play a key role in defining the quality, quantity, diversity, affordability, distribution and stability of the world's food supply, thereby affecting the achievement of the MDG hunger target**.** Limited access to infrastructure severely restricts the goods and services which are available to the rural poor, including electricity, telephones, schools, health centres and access to markets.

Widely dispersed populations, low volume economic activities, sparse service provision and distance between households are major challenges to cost effective rural infrastructure and require significant investments and new approaches, such as transport hubs, to be overcome. To address this, FAO has helped to analyse constraints and opportunities, developing policies and strategies to improve the competitiveness of rural agro-industries through improved rural agri-food transport.

A further prerequisite for rural development is the development of both on- and off-farm employment. While increases in labour productivity can help to promote decent, productive and remunerative rural employment, enabling the poor to earn a living wage, it can also contribute to rural and agricultural unemployment and increased short- and medium-term poverty, if productivity increases occur through capital intensive technologies.

Dramatic changes are occurring in agribusiness in all developing and transition countries, with the role of the private sector increasing, smallholder farming becoming commercialized – agribusiness enterprises are increasingly impacting on economic and social development, with significant implications for growth, poverty and food security. There is a rapid increase of value addition opportunities (relative to primary production), with increasing demand for farmers' products. Exporters and agroprocessing enterprises provide crucial inputs and services to farms, yet the changes pose challenges *inter alia* for farmers, traders, processors who face increased competitions and risk being excluded from modernizing agri-food chains. The Rural Infrastructure and Agroindustry Division of FAO is providing agribusiness development assistance to this sector.

III. Addressing land degradation, desertification and drought

Extent and impact of land degradation, desertification and drought

"Bankrupt environments lead to bankrupt nations –
and may ultimately lead to a bankrupt continent."

Little has changed for the better since the above statement was made about Africa in 1985. Land degradation is continuing and increasing in severity and impact and as such the supply of productive land in developing countries is under serious threat. If present trends continue two-thirds of Africa's croplands could effectively be non-productive by 2025 while simultaneously the total area and productivity of sub-Saharan Africa's traditional rangelands is decreasing. FAO plays a major role as a technical agency to accompany the UNCCD process, working to assist member countries to identify, assess and restore degraded lands.

Land degradation is recognized as highly complex phenomena, being highly variable, discontinuous, with different causes and affecting people differentially according to their economic and social circumstances. The significance of land degradation is global; it affects the livelihoods of 2.6 billion people in more that 100 countries, covering over 33 percent of the earth's surface. Estimates show that ca. 73 percent of rangelands in drylands are currently being degraded, together with 47 percent of marginal rainfed croplands and a significant percentage of irrigated croplands.

Current assessments are necessarily of limited accuracy and reliability, as the latest global map showing the extent and severity of different kinds of land degradation dates from 1990. There are no well-established quantitative global or regional data on the extent and rate of ongoing land degradation processes, only case studies. However, more detailed information on land degradation in drylands is becoming available with results from the GEF-funded and UNEP-implemented project Land Degradation Assessment in Drylands (LADA). With international and national partners, FAO as executing agency is developing a land monitoring system that provides a synthesis of resources and permits the identification of land degradation hot spots and bright spots at regional scale, using among others, remote sensing and climatic data. LADA is also identifying sustainable agro-ecosystems, land uses and management practices that deserve to be supported and promoted elsewhere.

Land degradation and desertification affects the poor and most marginal rural people worldwide disproportionately. Thirty-seven percent of the world's population (estimated to be close to one billion) live on land that is at risk or actually degraded in drylands. Yet it is only in the last fifteen years that it has it been recognized that the primary drivers of degradation may occur at levels beyond the land user; for example, at the policies that drive land users to have to mine their soil resources to survive. Land degradation is now recognized as a component of global environmental change, with synergies and linkages to others, particularly biodiversity and climate change. New projects to address land degradation are adopting ecosystem approaches, to gain major global benefits promoting sustainable land management as the conduit to conservation of biodiversity, adaptation and mitigation of climate change and prevention of land degradation.

To address the pressures on land resources in drylands, particularly the increasing demand for goods and services with unprecedented rates of land degradation, combating land degradation must be upscaled through appropriate land uses and management technologies and approaches, then mainstreamed into government and organizations' policies, programmes and strategies, particularly at the national level.

Latest experience shows that the main barriers which must be overcome are:

- Knowledge and technological barriers – although a wealth of information exists on successful SLM technologies and approaches, recent surveys showed that there is insufficient sharing of experiences at the local, national and regional levels. There are also still many knowledge gaps particularly on the economic and financial aspects of combating desertification.
- Policy, institutional and governance barriers – while there are many achievements, land degradation issues are not yet fully understood, internalized and prioritized in country poverty reduction strategies, public expenditure frameworks and sectoral development policies.
- Economic and financial barriers – have resulted in the financial resources available for combating desertification in general and to the agriculture and rural sectors in particular not being commensurate to the needs. As a conclusion, achieving combating desertification requires a drastic shift in emphasis.
- Up-scaling can only be achieved if the main bottlenecks that prevent combating desertification are overcome. To clearly understand specific bottlenecks in a given context, a participatory diagnostic must be carried out which will clarify priority areas and ensure that investments remove the major constraints to achieving the desired result.

To combat desertification, speedy, well-targeted actions must be implemented in the areas most affected or threatened by desertification. To achieve this objective, additional efforts are required at the international level to build up an optimized and coordinated programme, currently these efforts are insufficient, despite all the declarations made during the last years. A stronger commitment, also supported by facts, needs to be made by the main national actors concerned by desertification, when this problem has been identified as a national priority.

Planning for sustainable land management

In 1992, Agenda 21 recognized the need for integrated planning and management of land resources, stating that it should be a decision-making process that "facilitates the allocation of land to the uses that provide the greatest sustainable benefits" (Agenda 21, paragraph 10.5). Land use planning is even more crucial today, with growing pressures from climate change, urbanization and biofuels. Much high potential land is being lost to settlements; land which previously grew food crops is being planted with feedstocks for biofuels rather than food; climate change is limiting arable cropping in drylands, reducing productivity of rangelands and increasing sea levels, creating problems in coastal areas.

Approaches to sustainable land management

Healthy ecosystems in farming landscapes (agro-ecosystems) are critical for the long-term sustainability and productivity of agriculture. Integrated systems of agricultural production such as organic agriculture, integrated pest management or conservation agriculture need to be developed for each situation for improved use of soil and water resources (through better soil cover, rotations, organic matter management, soil and water conservation and watershed management). Explicit management of biodiversity at habitat and genetic levels is required to enhance ecological services such as pollination, soil

biological activity and pest-predator relationships. In this way, as it intensifies agriculture can work with, not against, the services that nature provides to human livelihoods.

Recent years have shown substantial progress and experience-sharing on integrated river basin management approaches and tools with attention focusing on land-water interactions, also the importance of inter-sectoral planning and management, integrated water resources management (IWRM) and effects of climate change. Achievements include flood control, water resources management and social economic development in the basin through, *inter alia*, water resources administration and dispute resolution; development of a basin plan and flood control scheme, guidance and integrated management of surface and ground water and soil erosion monitoring and control in vulnerable areas. Lessons learned and achievements have been reported through several international and regional conferences. Many regional and national projects are now promoting inter-sectoral and multi-stakeholder approaches to mitigate the causes and negative impacts of land degradation on the structural and functional integrity of ecosystems (including whole river basins).

Forests and trees are key components of arid zone ecosystems and contribute to maintaining suitable conditions for agriculture, rangeland management and rural livelihoods. The natural distribution of trees in arid lands is conditioned by biophysical limiting factors, such as climate soil quality and water availability – most tree species in drylands are highly dependant of specific ecological conditions. Usually, woody vegetation concentrates where runoff water can accumulate or where ground water is accessible. This leads to the uneven distribution of trees and bushes in drylands, which is also much affected by livestock grazing. Afforestation was found successful where local people are involved all along the process, large single species stands are avoided and locally adapted species used. Restored land and vegetative cover should be protected from the causes of their degradation (*inter alia* harvesting, grazing and fires) – in most cases, planting of trees is not required, as the vegetation is able to follow a natural succession, even on bare lands.

It is generally assumed that indigenous knowledge is a key factor in the management and conservation of biodiversity in drylands, although it is still underestimated and often not acknowledged. FAO has been involved in several projects and approaches that are promoting a "bottom-up" development of technologies, actively involving farmers, addressing the needs of men and women farmers, building on their local knowledge and accepting their advice.

Drought management and early warning system

Coping with drought is a vital element for sustainable agriculture in the twenty-first century. Over the short term, interventions on the "demand" can be addressed through campaigns for immediate water saving measures and water use restrictions associated to incentives. Interventions on the "supply" can be addressed through the temporary transfer of water rights, the use of low quality water and waste water re-use. Water conservation practices through crop and soil management practices represent an important area of intervention at the farm level (informed selection of crop patterns along with tillage and land-forming practices that favour rainfall infiltration).

Over the medium to long term, demand management can be addressed through improvements in water saving measures, water use efficiency and water productivity. Examples include the adoption of improved crop varieties and improved irrigation efficiency. As with other new approaches and technologies, the introduction and promotion of these new management options need to be backed up by extension and research.

Developed countries cope with drought by investing in water systems to mitigate the effects of water shortage and by establishing strong institutional frameworks that provide insurance to farmers and affected communities. In many developing countries, communities in areas prone to severe drought often have indigenous ways of coping. However, traditional systems may not be able to cope with the increasing frequency of droughts – more investment, for example in water storage

and distribution systems (traditional and modern), is costly but vital for many developing countries to mitigate the predicted impacts of climate change.

In the face of climate change in developing countries, drought early warning systems and information networks need to be further developed. A number of drought early warning systems have been established, but improvements are needed in their ability to deliver timely, accurate warnings and in their coupling with the response mechanisms. Of particular relevance is the improvement of seasonal forecasts, i.e. forecasts beyond the timescale of traditional weather forecasts, which typically do not exceed ten days. A better understanding of the longer-term mechanisms of climate variability, such as El Niño, has the potential to avert the most serious impacts of droughts and floods when coupled with impact simulation models.

Land tenure, access to land and other productive resources

A crucial priority in overall development strategies, is securing access to land and other natural resources for the rural poor. Rural landlessness is often the best predictor of poverty and hunger; the poorest are usually landless or have limited access.

The lack or poor definition of property rights to land and water is particularly problematic for poor rural land users, preventing them from undertaking the necessary investments to achieve a sustainable pattern of natural resource management. Where the poor do have rights over resources, they are often held as common property. Common property arrangements can lead to coordination issues that complicate provision of environmental services. Various forms of programmes to address the issue of property rights have been undertaken in developing countries, including agrarian reform, community forestry and land titling programmes.

Registration programmes have proved slow, expensive and difficult to keep up-to-date. Consequently, for example, the formal administration of land tenure in Africa mainly covers urban centres (between 2 and 10 percent of the land), with very little rural land registered. Attempts to improve legal security of tenure in rural areas (including to customary rights) have been constrained by the fact that key institutions (courts and registries) are frequently located far from rural users, thus hard to access. Many land administration agencies also suffer from insufficient financing and human capacity. There is a need for governments to improve the ability of land agencies to provide affordable and sustainable services in rural areas, particularly in areas of high-value land, such as peri-urban and irrigated areas, where competition is particularly fierce.

Simple, low-cost, accessible forms of land records and the registration of community land rights, through tools and institutions adapted to local conditions have recently been developed and are contributing to a broader, more appropriate tenure security strategy.

IV. Challenges and other emerging issues

Climate change in agriculture and natural resources base

The Stern Report (2006) concluded that the scientific evidence that human-induced climate change is a serious and urgent issue is now compelling and that the costs of inaction far outweigh those of mitigation and adaptation. The IPCC Fourth Assessment Report (2007) provided further scientific validation of climate change.

Food insecure developing countries with already fragile environments are particularly vulnerable to the impacts of climate change, due to impacts on food production (effects on crop, pastures, forests and livestock, shifting climatic zones, effects on soils and loss of habitats of harvested and wild species used for food and livelihoods). They have less ability to invest in research or infrastructure to mitigate climate change effects or compensate through greater food imports. Climatic change could also result in significant land use changes, e.g. conversion of forests to cropland, large population migrations and conflicts, which also carry significant costs. Besides climate change per se, it is the increased climatic variability and long-term fluctuations in weather patterns that are expected to have extreme impacts on agricultural production. Effects already being

felt include unpredictable seasons and farming, reduced crop yields, increased incidence and risks of pests and vector-borne diseases.

Many agricultural lands are already being affected by climate change, through the increased occurrence of droughts and flash floods. The choice of the most appropriate measures or actions to combat drought depend on the time frame under consideration (short, medium or long term), the selected intervention strategy (acting on the demand or on the supply of water) and the system that is going to be affected by the drought (food security, agricultural production system in general, etc.).

In response, FAO and partners are helping countries to adapt and adopt agriculture and forest management practices that generate socio-economic benefits and ensure sustainable use of resources, while also contributing to climate change adaptation and mitigation through reducing GHG emissions and increasing carbon sequestration in soils, plants and trees. This includes technologies for water use efficiency (water harvesting, supplementary irrigation), soil health and fertility restoration (conservation agriculture, soil organic matter management, improved fallows, fire management, agroforestry) and sustainable forest management (silvicultural practices, rehabilitation of degraded forests), as well as maintaining agrobiodiversity to increase resilience to changing environmental conditions and stresses (e.g. agro-silvo-pastoral systems, sustainable use of indigenous and locally-adapted plant species/varieties and animal races); and reducing vulnerability through crop yield forecasting, early warning and risk management.

FAO and the International Institute for Applied Systems Analysis (IIASA) published the results of a global agro-ecological assessment for agriculture in the twenty-first century. The findings confirm the likely extent of changes which will occur in land productivity for main crops due to climate change, both by agro-ecological zone and by subregions of the world, based on soil constraints and climate. This information is vital for planning at all levels for climate risk assessment, food security, index-based crop insurance, trade, market planning, also food storage and distribution.

Biofuel conflict with land resources and food security

Worldwide, 2.4 billion people rely on traditional biomass fuels (wood, charcoal, animal manure) to meet their energy requirements, with well known impacts on the environment, health and labour. This situation is likely to prevail for the foreseeable future – although developments of more fuel efficient stoves, wider distribution of solar cookers and rural electrification, particularly from renewables (hydro, wind, solar) have been demonstrated, but will require enormous efforts in up-scaling to make an impact.

Modern forms of bioenergy have rapidly emerged onto the international agenda in the past five years and their wider implications are having significant effects in many countries. Global biofuel production is expected to double over the next four years – mainly driven by demand in the USA and the EU. Bioenergy is claimed to be a win-win option, demonstrating some potential for agricultural diversification, to fill the rural energy gap, reducing national expenditures on oil imports and decreasing global dependency on fossil fuels. The industry is increasingly contributing to rural employment and development: bioethanol production employs 1 million low skilled and poor workers in rural Brazil and China's biofuel programme is expected to create up to 9.26 million jobs. However, the main consumers and thus beneficiaries of biofuels are expected to continue to be developed countries.

Biofuels can help to reduce greenhouse gas emissions but they are only part of the answer. Rapid growth in energy crop production is likely to place substantial demands on the world's land, forests and water resources at a time when other demands for these same resources are rising rapidly. Expansion of the energy cropland frontier over pristine ecosystems could lead to significant biodiversity loss, nutrient leaching and release of carbon from soil and vegetation.

Developments in "second generation" biofuels, involving advanced fuel production technologies which convert lower value agricultural crops and residues (maize stalks, coconut waste), also by-products of forestry

(wood chips, etc.) into fuels should have fewer negative impacts on food and environmental systems – and have better CO_2 performance than first generation biofuels. These fuel production technologies are not yet available on a fully commercial scale and are expected to enter the market in the coming eight to ten years. At that time there will likely be a continuation of first generation technologies accompanied by gradual transition to second generation technologies supported by the perennial crops.

Unless policies are enacted and best practices put in place to ensure pro-poor, sustainable development of "first generation" biofuels, the environmental and social damage will outweigh the benefits. More thorough analysis is vital, as the costs (environmental, economic and social) and benefits of biofuels vary widely between countries, feedstocks and markets.

Managing pests and transboundary diseases

FAO has a major role to play in preparing its members to mitigate the impacts of transboundary pests and diseases especially with the potential impact of climatic changes. The FAO Emergency Prevention System (EMPRES) for Transboundary Animal and Plant Pests and Diseases has been successful in helping to minimize the risk of emergencies associated with agricultural pests and diseases through surveillance, early warning, rapid responses and rehabilitation. The Desert Locust Information System has produced monthly reports, updates, alerts and forecasts of Desert Locust risks for over 28 years. FAO is in the process of adapting this weather-driven forecasting system to a recently emerging plant disease, a wheat stem rust, which has spread from Eastern Africa into the Near East and now threatens South Asia.

FAO EMPRES has resulted in the successful global eradication of one type of rinderpest (the type that affects domestic livestock) and some progress in the containment of contagious bovine pleuropneumonia (CBPP), foot-and-mouth disease (FMD), contagious caprine pleuropneumonia (CCPP), *peste de petit ruminants* (PPR), Rift Valley fever (RVF), and lumpy skin disease.

As many infectious diseases are zoonotic, FAO, OIE and the World Health Organization (WHO) combined and coordinated their alert and response mechanisms in 2006 in the joint Global Early Warning and Response System (GLEWS) in order to improve containment and control of major animal diseases. The overall aim of GLEWS is to improve capacity for early warning and response to animal disease threats through information sharing, epidemiological analysis and joint field missions to assess and control outbreaks across the world.

Incentives for good stewardship and payment for environmental services

National governments have a central role in encouraging good stewardship of the range of agro-ecosystems under their jurisdiction. Governments should themselves be investing to promote adoption of conservation agriculture, organic agriculture, eco-labelling and extension services as these bring multiple benefits – increasing agricultural yields and their reliability, also increasing the financial returns on particular agricultural products. By creating more profitable farming systems, governments will create more dynamic rural communities, contributing to reversing the tide of young people leaving rural areas of developing countries, disillusioned with the prospects of working in smallholder agriculture.

There is a growing recognition that land provides a range of valuable ecosystem services (as presented in the Millennium Ecosystem Assessment) in addition to food, feed and fibre. Appropriate mechanisms and approaches, including innovative market based solutions, are urgently needed to generate income flows to rural communities and institutions that conserve the rural landscapes which provide these services, as a direct incentive for them to continue to do so.

Besides project or programme funding by national governments, international agencies including development banks, donor countries and an increasing range of financing mechanisms has stimulated integrated land resources management in the last decade. These include payments for "ecosystem services" such as water supply and quality, also payments for carbon sequestration –

regulated under international agreements such as the Clean Development Mechanism, also in the form of voluntary contributions through non-governmental initiatives. FAO recognizes the role of ecosystem services in sustaining agricultural productivity, protecting crops and plants, and providing resilience in the face of changing climates and other stress from food production. It is working with member countries, communities and other stakeholders which increases farmers' productive capacity to ensure resilience and provide environmental goods and services.

V. Accelerating Progress and Means of implementation

Investment in agriculture

The greatest need over the next decade is to guarantee sufficient levels of investment in sustainable agriculture and rural development to ensure that the reductions required in rural and global poverty are achieved by 2015. Despite expressed global commitments to poverty reduction, the annual average allocations of Official Development Assistance (ODA) for agriculture in the least-developed and other low-income countries fell by 57 percent between 1983-1987 and 1998-2000. The key challenge to be addressed by governments at CSD is how to mobilize the total public investment in agriculture, rural development and direct access to food of US$24 billion per year that is needed to meet the MDG-1 hunger target.

Rural investment priorities vary by region, in keeping with the specific challenges they face. In **Africa**: extending the area under SLM and reliable water control systems, to expand irrigated agriculture, reduce overdependence on unreliable rainfall and improve soil fertility. In **Asia and the Pacific**, many countries have successfully increased production and yields of basic food crops. The challenge is to build on this success by raising and diversifying incomes to reduce poverty, create employment and secure entitlement to land. In **Latin America and the Caribbean** very limited off-farm employment opportunities in rural areas seriously constrain the diversification of job opportunities, the possibility of increasing incomes in rural areas and improvements in the living conditions of rural families. Reducing rural poverty and hunger in the **Near East** will require improved management of water, the critical resource for agriculture and rural development, as well as investment in infrastructure, knowledge, and well-managed institutions. Agriculture in **countries in transition** has experienced a sharp fall in output and productivity since independence. Investment in rural areas has been neglected and rural poverty is pervasive. Enhanced collaboration and innovative institutional mechanisms among suppliers, farmers, rural entrepreneurs, processors and product markets will be needed to expand agricultural production and diversify the economy.

In addition to direct investment in sustainable agriculture, investments and incentives are also vital to lighten agriculture's environmental footprint and ensure that in addition to food and fibre, world agriculture provides sustainable ecosystem services to the wider environment; supplying drinking water, maintaining a stock of continuously evolving genetic resources, preserving and regenerating soils, fixing nitrogen and carbon, controlling floods, filtering pollutants, pollinate crops and much more.

Climate change is already having profound and irreversible impacts on the economic, social and environmental systems of many developing countries. Across the globe, developing countries are the most vulnerable and bear the highest risks to their natural resources, due to a significantly increased temperatures and water constraints, yet contribute the smallest amount of the total carbon dioxide (CO_2) emissions per year when compared to other regions. Based on the principle that the polluter pays, additional investment from developed countries is vital to assist developing countries in adapting to climate change and its associated variability.

Enabling international and domestic factors: trade, price and incentives

Over the past four decades, the developing countries have seen a major decline in the share of agricultural exports in their total merchandise exports, together with a slower decline in the share of agriculture in their total imports. They have moved from a positive net agricultural trade position, with exports exceeding imports by a significant proportion,

to a situation in which agricultural imports and exports have been roughly balanced in recent years.

The Least Developed Countries (LDCs) have moved from a position of net agricultural exporters to one of net agricultural importers and since the late 1980s their agricultural trade deficit has widened rapidly. Simultaneously, LDCs display a strikingly low degree of integration of their agriculture sector into world markets compared with the developing countries overall.

The impact of trade policy on poverty, food security and inequality in developing countries is at the centre of a crowded international debate on the role of international trade in development. The current Doha Round of trade negotiations makes development and poverty impacts a top priority. Increased openness to international trade is unlikely, on its own, to lead to major improvements in economic growth or poverty reduction and the same is true for food insecurity. Complementary policies, including public investments in pro-poor growth strategies and safety nets, are crucial if trade liberalization is to support food security strategies. Agricultural trade can contribute to an agriculture-based development strategy and the liberalization of trade in agricultural products can have beneficial effects. Developing countries can ensure that their own trade regimes are as conducive as possible to stimulating growth in the agriculture sector.

A recent World Bank report (2007) notes that "there has been relatively little progress in the overall decline in producer support in member countries of the Organisation for Economic Co-operation and Development (OECD). Producer support declined from 37 percent of gross value of farm receipts in 1986-1988 to 30 percent in 2003-2005. There has been a shift away from support directly linked to product prices to other less-distorting forms such as cash transfers "decoupled" from production, particularly in the European Union. But such transfers are not always neutral for production because they reduce aversion to risk (wealth effect), reduce the variability in farm income (insurance effect), and allow banks to make loans to farmers that they otherwise would not. The estimated welfare impacts of full trade liberalization are relatively large. By removing their current level of protection, industrial countries would induce annual welfare gains for developing countries estimated to be five times the current annual flow of aid to agriculture. But this impact is heterogeneous across products and countries."

Many factors are working against the developing countries in particular in their efforts to diversify and expand agricultural exports. Firstly, despite the Uruguay Round, tariff barriers continue to be high for processed agricultural products and many processed food products are subject to binding Tariff Rate Quotas. Secondly, these products (especially foods) face stringent technical standard requirements on sanitary grounds. For many developing countries, especially in sub-Saharan Africa, it is very difficult to meet these standards in high income countries. Thirdly, there are difficult supply-side constraints that require large-scale investments in infrastructures and other trade-related facilities to resolve the bottlenecks.

The Doha Round is seen as an opportunity to resolve some of these problems. An ambitious agreement on market access, for example, would dismantle tariff peaks and reduce tariff escalation, the phenomenon where tariffs rise along the processing chain and thus hurt the development of value-adding, processing industries. More market access could be created if trade-distorting production subsidies are reduced significantly and various indirect forms of export subsidies disciplined. The Aid-for-Trade initiative launched at the Hong Kong WTO Ministerial in 2005 further promises investments in trade-related supply-side constraints. At this stage, however, there are many questions and doubts about whether all these initiatives underway will be carried through effectively.

There is obviously a vast scope for expanding intra-African trade in agriculture, especially in food products. During 2002-04, total agricultural import of Africa was US$25 billion, with 80 percent of this being foods. Food sector has been Africa's most dynamic agricultural sector in terms of demand growth, and this being reflected in import

growth from outside the continent. With intra-trade in Africa of 15-20 percent only, there is a vast market for regional trade. It is expected that the recent initiatives to remove the barriers to intra-African trade would expand intra-trade considerably, as has happened elsewhere in the world.

Data and information system – the knowledge gap

High quality, timely information is vital to support improved decision making for sustainable agriculture at all levels, particularly to ensure successful adaptation to climate change.

Our knowledge on the resource base (soils, water, terrain, climate, land use and socio-economic setting) has increased in some major aspects in recent years, for example on the trends in vegetative cover due not only to the availability of high resolution satellite images, but particularly the existence of global projects analysing and disseminating them near real-time via the internet.

However, knowledge of the resource base has stagnated in others areas. The mapping of soils has not progressed since the late 1980s, the latest global map showing the extent and severity of different kinds of land degradation dates from 1990, few information systems exist on many important aspects of agricultural land use and management at subnational levels and forest programmes increasingly rely on out-of-date and incomplete soil information. Survey results are rarely accessible to local farmers or service providers because of the specialized terminology.

To overcome this knowledge gap, FAO, together with partners, has newly developed, updated or further enhanced its global information systems on the resources base, including the state of forests; statistics on water availability, quality and use; land suitability and potential changes in land suitability due to climate change; and soil and terrain characteristics. Other databases that enhance access to information and technologies deal with land degradation.

A major weakness of drought monitoring and crop forecasting systems at this time of increasing weather variability and rapid climate change is the lack of basic observations about weather. National networks of meteorological stations have been dramatically depleted in many countries over the last 30 years, making impact assessments more uncertain in face of the increasing frequency of constraints on agricultural production systems. Satellite imagery and other new sources of data are very useful, but no substitute for ground observations, indeed satellite imagery requires such data for calibration. Impact assessment models and tools have now reached a high degree of sophistication, while the data, including crop and climate data needed to operate them, is deteriorating.

Technology Transfer – strengthening human and institutional capacity

Agricultural research and extension have a vital role in meeting the MDGs and the WFS target through promoting access to relevant agricultural knowledge and technologies, particularly for the poor. Lessons from across Africa show that the effectiveness of agricultural technology generation and dissemination institutions is significantly influenced by its relevance and responsiveness to farmer needs. Regrettably to date, farmers' needs have not been the main drivers of the agricultural research and extension services; limiting their relevance and impact. Even when relevant, know-how and technologies have too often not been widely taken-up by farmers, indicating ineffectual technology transfer.

Learner centred capacity building for land users has proved to be crucial to building and sustaining progress, including sharing new approaches, farmer-led innovation and the dissemination of new technologies (e.g. conservation agriculture). Examples of successes include community-based land or watershed planning and management and Farmer Field School approaches for integrated soil management.

Particular efforts will be required to ensure that developing countries gain maximum benefits from advances in biotechnology. Most biotechnology is generated and controlled by large private-sector companies, which have mainly targeted commercial farmers who can afford their products. Technologies and intermediate products developed through private-sector research could also be adapted to

solve priority problems in the developing countries. If the poor in these countries are to reap this potential, national and international action is needed to foster private-public partnerships that will promote access to these technologies at affordable prices.

Studies have shown that investments in agricultural research and technology development have very high rates of return, generally exceeding 30 percent per year and its impact on poverty reduction has been considerable, yet public spending on agricultural research in Africa has fallen from 0.8 percent of agricultural GDP in the 1980s to 0.3 percent in the 1990s.

Sustained, coordinated support to, and adequate investment in, agricultural research and extension by the public and private sectors, bilateral and multilateral agencies, and technical-support organizations is crucial if governments are to create the knowledge and technology base required to achieve and maintain comprehensive food security for all.

VI. Conclusion

The global challenge of ending hunger through harnessing sustainable natural resource use for agriculture and rural development comes at a time of worldwide accelerated population growth, urbanization, migration and sustained economic growth; pressures further exacerbated by climate change, loss of biodiversity, growing water scarcity, liberalized trade regimes and inappropriate technology applications.

The engine of agriculture has proved uniquely powerful in the past to help people escape poverty and hunger – it should again be put at the centre of the development agenda in the twenty-first century, with a new, innovative green revolution for sustainable development, including poverty reduction and sustainable use of resources and ecosystems. The achievement MDG-1 will depend upon development in rural areas, with sustainable agriculture increasing the assets of poor households, through both increasing productivity and creating opportunities in the rural non-farm economy. Attainment of MDG-7 also requires the realization of sustainable agriculture systems. World agriculture must play a much wider range of roles than ever before, not only guaranteeing food security for the global population and a source of livelihood for billions of people, but also providing sustainable ecosystem services to the wider environment.

Governments and the international community should work to reverse years of policy neglect, underinvestment and ill-advised investment in agriculture. They must also ensure access to land and other natural resources for the rural poor. The answer is not to slow agricultural development, but to ensure that only sustainable solutions are adopted – sustainable intensification through managed inputs, restoring resilient, integrated agro-ecosystems, with appropriate use of advances in biotechnology. These agro-ecosystems will also contribute to the adaptation to, and mitigation of, climate change, the development of both on- and off-farm employment and development of agribusinesses with significant implications for growth, poverty and food security. Progress towards meeting MDGs and the World Food Target will be accelerated through international trade, closing the knowledge gap and ensuring that appropriate technologies are made available to poor farmers in developing countries – custodians of vast areas of globally important agro-ecosystems.

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