The Economic Potentials of the UNCCD Implementation

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Introduction on the UNCCD

Desertification affects arid regions throughout the world, causing underdevelopment of economies and inflicting destitution on the populations of vast areas and threatening them with famine. Reversing the processes by which desertification invades arable lands turning them into desolate wastes is one of the most crucial challenges facing the communities and nations of arid regions.

AGENDA 21 of the United Nations Conference on Environment and Development (UNCED) emphasizes the need and proposes a wide range of activities to address land degradation in general and desertification in particular. As a response to this challenge, more than 190 countries are Parties to the United Nations Convention to Combat Desertification (UNCCD).

Desertification occurs because drylands ecosystems, which cover over one third of the world's land area, are extremely vulnerable to over-exploitation and inappropriate land use that result in underdevelopment of economies and in entranced poverty among the affected population. Poverty, political instability, deforestation, overgrazing, and bad irrigation practices can all undermine the land's productivity leading to underdevelopment of economies. Over 250 million people are directly affected by desertification. In addition, some one billion people in over one hundred countries are at risk. These people include many of the world's poorest, most marginalized, and politically weak citizens.

The international community has long recognized that desertification is a major economic, social and environmental problem of concern to many countries in all regions of the world. In 1977, the United Nations Conference on Desertification (UNCOD) adopted a Plan of Action to Combat Desertification (PACD). Unfortunately, despite this and other efforts, the United Nations Environment Programme (UNEP) concluded in 1991 that the problem of land degradation in arid, semi-arid and dry sub-humid areas had intensified, undermining the development of economies as poverty increased, although there were "local examples of success".

As a result, the question of how to tackle desertification was still a major concern for the United Nations Conference on Environment and Development (UNCED), which was held in Rio de Janeiro in 1992. The Conference supported a new, integrated approach to the problem, emphasizing action to promote sustainable economic development at the rural community levels. It also called on the United Nations General Assembly to establish an Intergovernmental Negotiating Committee (INCD) to prepare, by June 1994, a Convention to Combat Desertification, particularly in Africa. The Convention was adopted in Paris on 17 June 1994. Over 192 countries are Parties to the Convention.

The United Nations Convention to Combat Desertification was negotiated and adopted on the recognition of the negative consequences of land degradation and the effects of drought on sustainable economic development in affected countries. It is common knowledge that land degradation constitutes a major cause of poverty, forced human migration, deadly conflicts, starvation, and destruction of critical habitats, socio-economic instability and climatic variability

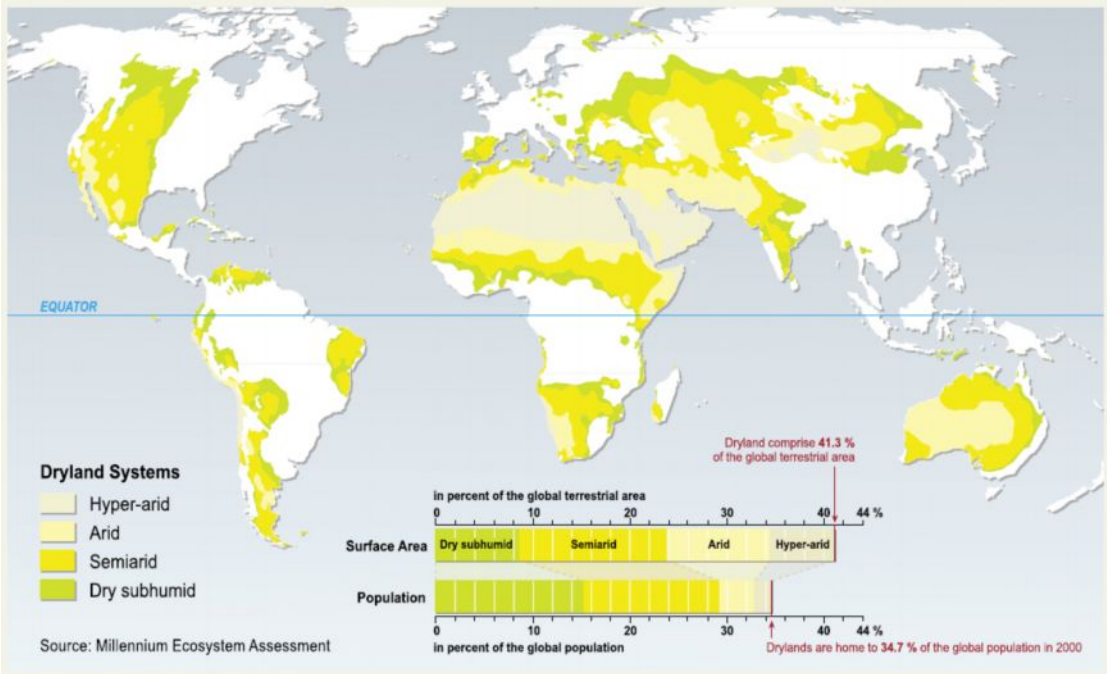
through reduced carbon sequestration potential. All these, have a strong bearing on the sustainable development of economies in arid regions of the world.

While desertification affects all arid regions of the world, it has its greatest impact in Africa where two thirds of the continent is desert or drylands. Arid regions of the world have witnessed a series of drastic changes in land use, technology, demographic, farming capabilities, economic demands on the resource base, allocation of land and changes in political inclination. All of these have had an impact on the quality and quantity of the natural resource base.

Arid regions have experienced a number of environmental problems that are mainly a result of human activities that are intractably bonded to underdevelopment and poverty, particularly so, in developing countries. Spates of droughts and floods have compounded the problems. The single biggest problem is that of land resources degradation, resulting from accelerated soil erosion emanating from excessive exploitation of the natural environment in ecologically marginal, dry and fragile soils mainly in rural areas without alternative economic activities. The process of land degradation is marked by forage and soil degradation, especially in arid and semi-arid lands that are used beyond their capacity for sustained agricultural production.

Fig I: Present-day Drylands and Their Categories

The map is based on data from UNEP Geo Data Portal (http://geodata.grid.unep.ch/). Global area based on Digital Chart of the World data (147,573,196.6 square km); Data presented in the graph are from the MA core database for the year 2000.



Whereas over cultivation, inappropriate agricultural practices, overgrazing and deforestation have been previously identified as the major causes of land degradation and desertification, it is in fact a result of much deeper underlying forces of socio-economic nature, such as poverty and total dependency on natural resources for survival by the poor. Since most economies of developing countries are mostly agro-based, a greater proportion of the environmental problems in rural areas are related to agricultural practices and other land use systems. It is also true to reiterate that land degradation problems are best understood within the dictates of disparities of income and access to or ownership of resources.

The over-dependence of poverty stricken rural communities on natural resources to meet their daily requirements contribute to massive natural resources degradation, which in turn lead to soil erosion, land degradation and water shortages through the siltation of rivers and dams, subsequently leading to entrenched poverty among the affected populations. Land degradation in arid regions is also a result of poverty-induced clearance of vegetation for agriculture and settlement purposes, overgrazing and burning.

The losses of natural soil cover contribute to soil erosion, biodiversity loss and to desertification. As stated above, soil erosion in turn lead to siltation of rivers and other water bodies resulting in negative effects on the economies and living standards of the affected communities. Unfortunately, the rate of land degradation and entrenchment of poverty appear set to continue accelerating as the populations in arid regions of the world continue to increase.

On the other hand, the poverty–environment relationship contributes to natural resources degradation and this issue needs to be treated with the seriousness it deserves. The poor become both the victims and willing agents of environmental damage as a large and growing population, struggling to survive in a limited land resource base result in the over-utilization of the available natural resources. Because of lack of alternative livelihoods over-utilization of resources lead to further poverty and environmental degradation.

UNCED recognised the intricate linkages between desertification, poverty and underdevelopment of economies in developing countries. Desertification undermines development of economies and this in turn reduces the potential of generating resources for investing in combating desertification and environmental degradation. It can be agued therefore that the protection of the environment and of natural resources is an essential part of the development of economies that require concerted efforts to reverse the processes by which desertification, undermine the development of these economies.

The development of national economies in arid regions is not only a moral imperative but also a prerequisite for environmental sustainability and sustainable development. However the international community has spent millions of dollars on multitudes of projects and programmes over the last decades in an effort to reverse the negative effects of desertification across the globe but there are limited tangible results on the ground to show for this determination and justify the resources spent. Consequently, serious questions can be asked in search for not only comprehensive, but also convincing answers to this international disastrous failure.

Reversing the retrogressive effects of desertification reduces conflicts over the use of depleting natural resources, human migration, poverty, climate variability and frequent and severe droughts, food insecurity and loss of biological diversity and life supporting systems.

Causes of Desertification

The causes of desertification are more complex to unravel. Desertification is driven by a group of core variables, most prominently climatic factors (Yang and Prince 2000; Hulme and Kelly 1993) that lead to reduced rainfall (Rowell et al. 1992) and human activities involving technological factors, institutional and policy factors, and economic factors (UNCCD 2004) in addition to population pressures, and land use patterns and practices.

The technological factors include innovations such as the adoption of water pumps, boreholes, and dams. The institutional and policy factors include agricultural growth policies such as land distribution and redistribution (AIBS 2004). These variables drive proximate causes of desertification such as the expansion of cropland and overgrazing, the extension of infrastructure, increased aridity, and wood extraction.

Also, deliberate policies to replace pastoralism with sedentary cultivation in rangelands lead to desertification. Promoting farming in rangelands that cannot sustain viable cropping systems contribute to desertification. The majority of dryland areas (65%) are rangelands that are more suited to sustainable pastoralism than crop production. Over the years, nomadic pastoralism proved to be a sustainable rangeland management practice suited to the ecosystem carrying capacity (MA 2005). Thus policies promoting permanent settlement in marginal drylands lead to desertification as people loose their ability to adjust economic activities in the face of stresses such as droughts.

Desertification is taking place due to factors that induce unsustainable use of scarce natural resources by local land users. Unsustainable natural resources management approaches adopted by land users, unable to respond adequately to factors such as population pressures and globalization lead to decreased land productivity and a downward spiral of worsening degradation and poverty. This situation may be further exacerbated by global climate change.

Thus human activities are the fundamental causes of desertification on the background of the natural fragility of dryland ecosystems that renders them extremely vulnerable to inappropriate land use and over-exploitation. The impact of human activities is aided by periods of environmental stress propelled by severe droughts and seasonal dryness. Given the inevitable many different forms of social, economic, and political pressure, over-exploitation of the land is bound to happen. On the other hand poverty and population increases bring about marginalization and push the affected population to exploit unsuitable and fragile land. Unless such pressures are eased, drylands ecosystems will remain increasingly vulnerable to desertification.

The management of drylands requires flexibility to be able to adapt to natural changes in climatic conditions. In the past a range of techniques were employed to protect valuable water resources, vegetation, soil quality and crops. However, economic and political pressures as well as changing cultures, population sizes, trends towards more settled communities and a lack of respect for the land resulted in increasing mismanagement of land and the failure to adapt to fluctuations in climate (Grove 1973). This often leads to the adoption of land use practices unsuitable for the existing climatic regimes, or the over-intensification of existing practices until they become damaging to the land (Glantz, M. H, and Orlovsky, N. 1983;).

Over cultivation of crops and excessive tilling of the land leads to exhaustion of soil nutrients and land degradation (Aubreville, 1949) and crops harvested in drylands are often grown in soils already depleted in nutrients. The pressure to exploit the land in this way can be brought about by increases in food demand due to an increasing population, and monetary pressures such as the development of a cash-crop economy. However, under-cultivation can also lead to desertification in areas where there are no longer enough people to adequately manage the land. Soils, especially those of a sandy nature exploited in this way can become prone to wind erosion, whilst over cultivation of clay soils may well cause water erosion leading to land degradation.

Dryland populations can avoid land degradation by improving their agricultural practices. Agriculture can play either a positive or a negative role, depending on how it is managed. This in turn depends on the socioeconomic resources available, the policies adopted, and the quality of

governance. Local institutions, such as community-based land-use decision-making bodies and social networks, can contribute to preventing desertification by allowing land users to manage and use ecosystem services more effectively through enhanced access to land, capital, labour, and technology.

Low levels of technical know-how can often be a major cause behind poor land management practices such as irrigation. Poverty and underdevelopment are also major factors, but developed countries, including Spain, Australia and the United States, also suffer from desertification (Glantz, M. H, and Orlovsky, N. 1984). It has been shown that desertification can also result from road building, industrial construction, geological surveys, ore mining, settlement construction, irrigation facilities, and motor transport (Rozanov, 1977).

Security of tenure has also had an impact on desertification with land tenure practices and policies that encourage land users to overexploit land resources contributing to desertification. When land users lose control or long-term security over the land they use, the incentives for maintaining environmentally sustainable practices are lost. Problems of water scarcity, groundwater depletion, soil erosion, and salinization are often a result of deeper policy and institutional failures. Security of tenure such as long-established collective and community-based management practices often operate quite effectively with greater transparency and fairness in the allocation of resources to all stakeholders.

The Role of Agriculture on Desertification

High rural population growth rates and increased pressure on the natural environment have led to increased levels of desertification resulting in declining agricultural productivity that threaten food security. Consequently, in many parts of the world, the increasing needs of growing populations for food, fuel and fibber have led to desertification, severe soil erosion, loss of water resources, and eventually declining crop production and increased perilous food security.

Thus, the search for food security is related to a number of environmental threats, such as the depletion of natural resources, climate change (Desanker and Magadza 2001), air and water pollution, desertification and loss of habitat (McHarry et. al 2002). While local environmental problems have long been documented, the role of agriculture as culprit that causes desertification or its victim is far from being fully assessed (FAO 1994).

Accelerated demand for agricultural products exerts ever-increasing pressures on the natural resource base, resulting in excessive deforestation, loss of biological diversity, degradation of soils and desertification, and various forms of pollution and contamination and ultimately uncertain food security. Although agriculture will remain for many years a major contributor to the economies of most developing countries (Van Crowder *et al.* 1998), in some countries, however, its share of GDP will progressively decline as desertification takes its toll further necessitating the employment shift from agricultural to other sectors, exacerbating a precarious food security situation.

Already in most of countries affected by desertification, agriculture does not offer sufficient opportunities for gainful employment. Disparities in the living conditions of rural dwellers, and between rural and urban populations, are increasing (FAO/IFAD/WFP 2002). Yet agriculture is not only a source of food but also a prevailing way of life in most affected countries (Desanker and Magadza 2001).

As the effects of desertification are felt in many developing countries and farmers' incomes further become increasingly vulnerable to the vagaries of droughts farming populations are decreasing, leaving large degraded tracts of land largely unattended, with growing risks of desertification as they migrate to urban areas. There is a visible and worrisome downward trend in the resources, private and public, directed towards agricultural and rural development, especially in those countries where desertification, hunger and poverty are widespread (FAO/IFAD/WFP 2002).

By the year 2025, an additional three billion people will have to be fed from a finite resource base (FAO 1994). Whilst food production has increased steadily in the last few years, there will need to be an increase of 100% by 2030 to meet the growth in demand. Already, more than 800 million people are undernourished (McHarry et. al 2002) and are threatened by food shortages and famine globally.

Further intensification of agriculture is therefore imperative to meet present and future demands and to avoid further encroachment on marginal lands and fragile ecosystems. Future increases will have to come from the same amount of land and water that is currently used, if further desertification, destruction of biodiversity and harm to the environment is to be avoided.

However, intensification as practiced at present, particularly in developed countries, carries with it problems of pollution and contamination, waste disposal and loss of biodiversity, which can affect not only the natural resources and the environment but also human health (FAO 1994). Meanwhile agricultural intensification in developing countries, more often than not, is a recipe of desertification.

A combined approach tackling consumption, as well as the production end of the food chain, is a part of the solution. Small scale and low cost technologies may be more of an answer than quick "technological" fixes which may carry uncertain risks of negative impacts (Madeley 2001).

Desertification, poverty, environmental degradation and resource depletion, have led to on-going risky food security and deterioration in the diversity of diet. In extreme cases, soil degradation can proceed to the point where the land becomes desert, and the impact of desertification - as a result of deforestation, overgrazing, poor cultivation and other processes - has greatly increased in recent decades (FAO 1994).

An average of 70% of the African population live on farming (Desanker and Magadza 2001) and 40% of all exports are earned from agricultural products (WWI 1996). The challenges in achieving food security are many: to reduce poverty, increase food security without further degrading natural resources and exacerbating desertification, and to cope with population growth.

The challenges can be seen on two levels. Firstly, to achieve subsistence or basic food security requires provision of the main dietary requirements to a population. Food security should aim to safeguard the rights and interests of local communities, allowing each individual the basic human right to have access to food (McHarry et. al 2002). Secondly, achieving food security must also contribute to sustainable agriculture, economic development, the achievement of sustainable food production and the effective reversal of the desertification process.

Millions of rural Africans are dependent on agriculture and natural resources for food security and meagre incomes. Policy impediments on critical issues such as market liberalization and land reform are leading to greater insecurity, and are yet to be resolved by governments (FAO/IFAD/WFP 2002). Recent efforts pursued the major goals of ensuring food security and

improving the living conditions of rural populations alongside those of conserving natural resources, protecting the environment and combating desertification (FAO 1994).

An important challenge is the building of capacity in affected countries for environmental management and combating desertification for sustainable rural economic development, food security and poverty eradication (Desanker and Magadza 2001). Much of the work done so far has been at the public level, but more effort is needed to involve the private sector and to alert affected populations to ways in which successful management of the environment and combating desertification can enhance food security and development progress of the rural economies upon which the majority of the population depend.

Imperatives for Africa Sustainable Development

1. Linking Environmental Management to Sustainable Development

In Africa, the successful management of the natural resources and rehabilitation of degraded and desertified lands to promote sustainable development requires the interventions of major scientific innovations and socio-economic fundamentals and shifts in ecosystem management approaches to overcome challenges related to desertification. Such interventions must be implemented at all levels from local to global scales, with the active participation of all key stakeholders. Improved information generation and information accessibility, would help enhance the enabling conditions for the effective management and rehabilitation of the desertified lands.

Policy measures should be put in place and enforced in support of the interventions to prevent and reverse the processes of desertification and mitigating the effects of drought. The measures should promote participation of key stakeholders, advocate for the creation of off-farm income opportunities that give impetus to rural development through industrialisation and provide implicit support for adaptation to desertification and drought. The role of small-scale industries in farmer household economies should be vigorously supported in development policies to strengthen existing off-farm household activities as sources of income for the rural population (Eriksen 2001).

Sustainable development initiatives should nature, as sources of alternative income-generating livelihoods that reduce dependence on declining natural resources, the growth of rural industries, and small-scale agricultural sectors (supported through introducing practices such as agroforestry, sustainable agricultural farming systems and soil conservation techniques), as interdependent entities in the process of becoming formidable economic development players. In tandem, the development initiatives should promote the conservation of native plants, local crop varieties and animals, advocate for the rational use of rangelands and developing of fodder crops and strengthen their role in food security and medicinal provision, with incentives given to local inhabitants to protect and conserve native varieties of plants and animals as drought and desertification adaptation measures.

Sustainable development initiatives that target changes in overall economic and institutional settings and advocate the creation of new opportunities for people to earn a living have the potential to help relieve pressures underlying the desertification processes. The gradual growth of rural service centres into urban areas, when undertaken with adequate planning and provision of services, infrastructure, and facilities, can be a major factor in relieving pressures that cause desertification in drylands. This view is relevant when considering the projected growth of the

urban fraction in drylands, which will increase to around 52% by 2010 and to 60% by 2030 (MA 2005). As economic opportunities are created in rural service centres in the drylands reducing dependants on the natural environment, desertification is avoided.

The need to establish and strengthen institutional mechanisms and organizational structures, both Governmental and non-governmental, at all levels with responsibilities for general planning is a major imperative for success of the strategic planning processes for sustainable development in Africa. Institutional reforms that include national environmental institutions (ministries, departments, commissions, etc), non-governmental organizations (NGOs), advocacy groups, and private-sector institutions should continue to be strengthened or established to take responsibility for the environment and to promote sustainable development initiatives and programmes as part of the strategic planning processes. Moreover, the establishment of these institutions helps pave the way for a more holistic and coherent approach to environment and development issues and minimize the problems that arise from fragmented and uncoordinated institutional initiatives (UNEP, 1995b).

Decentralization of central Government functions should take place, especially with respect to environmental planning to enhance opportunities for NGOs and grassroots participation in identification, planning, and implementation of environmental projects. Where institutions are weak, they should be strengthened and be adequately equipped to implement their functions through addressing such shortcomings as shortage of skilled human resources, inadequate training facilities, lack of integration and co-operation among major institutions and lack of requisite financial and technical resources and enhance vital capacity in ecological monitoring, natural resources mapping, remote sensing and early warning systems.

Increasingly, countries are preparing Environment Impact Assessment (EIA) guidelines and procedures as part of the general policies and directions being planned and implemented. On the other hand to strengthen capacity in terms of human resources, countries emphasize the need for environmental education, training, and information; the role of NGOs and the media; development and implementation of natural resource management projects; and the active participation of all stakeholders in the environmental management process.

Designation of protected areas has seen the establishment of natural terrestrial and aquatic reserves in the form of national parks, wildlife sanctuaries, gene pool reserves, etc and a dramatic rise in the number and total area of protected areas occurred in some drylands ecosystems to ensure the long-term survival of wildlife populations. For example several innovative wildlife management strategies, such as game ranching and community-based management schemes, offering promising and practical alternatives to the standard approaches to wildlife conservation are pioneered in southern Africa, such as the Communal Areas Management Programme For Indigenous Resources (CAMPFIRE) in Zimbabwe, the Administrative Management Design for Game Management Areas (ADMADE) in Zambia; and the Selous Conservation Programme in Tanzania (Makombe, 1993).

Under these participatory programmes, local communities raise revenues through sport hunting management, and hence fewer habitats are converted to agricultural land and poaching is prevented. Initiatives further focus on restoring lost and degraded habitats, mitigating human-wildlife conflicts, and establishing a database of the migration and population dynamics of the wildlife. In other developments, countries establish Environmental Information Systems (EIS) programmes and acquire electronic mail systems to facilitate information exchange with the external world.

Local inhabitants, given their time tested experiences and local knowledge, backed by modern science, dryland communities are in the best position to devise practices to prevent desertification. Consequently, putting in place policies that enable the participation of local inhabitants and their institutions as well as to improve their access to transport, market infrastructures, access to appropriate information and allow land users to innovate are essential to the successful implementation of measures to combat desertification.

2. Promoting Intra Regional Trade an Imperative for Africa

Solutions to the African environment and development dilemma have to come from within the region, making intra-regional trade in Africa not an option but an imperative for the African continent to sustainably eradicate poverty, unemployment and poor health systems among its challenges. The current situation where individual African countries have greater economic trade with European countries than their immediate neighbours put African countries at a greater disadvantage individually and collectively. Presently there is not much trade activity between and among African countries given a myriad of challenges that include tariff barriers, misconceptions about the quality of local products and other perceptions that lead many to believe that products from the continent are inferior to what the rest of the world produce (Ruzvidzo 2007). Consequently, Africa occupies a position of weakness on the international platform and therefore there is need for Africa to build capacity through increased trade within regional groups.

Poor trade between countries and within regional economic groupings is reflected in low socio-economic growth and the continent's inability to claim a significant share of global trade despite its rich endowment of natural resources. Africa command only 2,3 percent of world trade. Intra-Africa trade is the lowest compared to other regions such as the European Union and the North Atlantic Free Trade Area. This trend is likely to continue unabated if Africa does not do something about it more so that the western world refuse to invest realistically in the development of Africa, for fear of creating a monster that may be uncontrollable, just as the colonial settlers failed to educate the African peasant for fear of losing much-needed cheap, illiterate and naive farm labour (Awori 2004). Africa needs to increase trade within itself as a continent to enhance competitiveness on the international platform, building at the same time a formidable partnership between government and the private sector if meaningful development has to be achieved on the continent.

The sidelining of the private sector is a major drawback in fostering intra-regional trade while also compromising Africa's position on the world trade platform. Africa’s trade development should be all-inclusive in character so that every stakeholder can make an input. Also, to enhance trade, it is important that African countries liberalise trade amongst themselves through reduction of tariffs, putting in place more efficient customs systems, increasing political will to promote trade and adopting appropriate exchange rate policies for example. Liberal development policies, a favourable political atmosphere, dynamic government systems and, most important of all, educational and training programmes that identify and promote innovative practical skills among the youth are urgently needed. In addition, it is essential that African countries diversify their exports and establish appropriate regional trade arrangements that favour them to be able to influence world trade policies.

It is noteworthy that intra-regional trade is critical to economic development and poverty reduction in given that regional integration offers better markets while creating a bigger domestic territory amongst countries. It is, further, important for Africa to explore ways of modernising

trade facilitations in order to encourage more trade amongst countries in the same region. Apart from the essential technological and industrial inputs, Africa as a region has adequate human resources, experts and technical know-how for her basic development needs. Thus true and meaningful development is a preserve and right of the indigenous people of Africa. They, and only they, can evolve a realistic and sincere process of human development in the region.

Africa has had enough of unworkable development formulae and technical fixes hatched from outside. What the region requires is true and tangible resource support by way of substantial investment and development capital. With a meaningful capital base at her disposal, coupled with ample time to create and innovate solutions from within, there is no doubt that trade in this immensely resourceful region would match, and even surpass, the rest within the next five decades.

3. Improving the Management of Water Resources and Hydro-Geological Basins

Africa's population is expected to exceed 1 billion people by 2025. Population growth and economic development create excess demand over supply for most countries. The percentage of population without access to clean water or adequate sanitation is increasing, particularly in the rural and peri-urban areas. Making households water-secure and providing water to rain-fed and irrigated areas for food production will be key to reducing poverty in Africa. The poor, most of whom live in rural areas, have limited access to clean water for domestic use and crop production, and adequate sanitation.

Without sufficient supplies of clean water, water-borne and water-related diseases are common in the area. The diarrhoea death rate is the highest in the world. In urban areas, industrial pollution, poor sanitation practices, and discharge of untreated wastewater into surface and ground waters cause widespread water contamination. If farmers are to keep pace with population growth, they will have to intensify agriculture, increase crop yields, and significantly increase crop production. This requires increased production on both rain-fed and irrigated land. Over the last few decades, precipitation across much of the region has become increasingly variable and unreliable, unpredictable, and inadequate, often resulting in frequent, long and severe droughts. Throughout the region, and even within countries, there is an enormous variance in water amounts demanding the need for prudent water management strategies.

Unfortunately, more than 320 million hectares of vegetated lands have been degraded over the past several decades, causing flooding, reduced ground water recharge, and stream base-flow (Sharma, et al. 1996). In appropriate agricultural practices, deforestation, and overgrazing have had similar effects.

In response many African governments are developing and implementing National Action Programmes (NAPs) to Combat Desertification that highlight the importance of water in sustainable environmental management. Water resource assessments and the reform of water policies and institutions have been undertaken in many countries. National programs for water supply and sanitation are being developed and implemented across the region incorporating new ideas that focus on participation and private sector involvement.

At regional level, African countries have since established a Thematic Programme Network (TPN) on Improving the Management of International River, Lake and Hydro-geological Basins to address the needs for integrated water resource management, protection and conservation and

reach Africa's social, economic, and environmental goals in the context of implementing the United Nations Convention to Combat Desertification. The TPN provide the strategy and vision of the African countries on the modalities of regional cooperation, sharing, rational use and developing of water resources, to ensure clean water and sanitation services for all the region's inhabitants and for all the key sectors. The vision encompasses economic growth and food security and environmental sustainability through effective rehabilitation, development, conservation, management and protection of scarce water resources and sources. The TPN is meant to provide guidance for important choices and trade-offs, through balancing immediate economic benefits with long-term conservation, protection, management and sustainable use gains as well as endeavouring to reconcile the critical challenges of diverse interests at the local, national, and regional levels.

However, concerted support is needed to enable African countries to accelerate participatory approaches to water resources management. Countries need to develop market-demand-driven solutions and adopt economically viable policies and measures for allocating water, pricing and investing in water resources development, management, protection and conservation. National governments need to create laws and regulations that provide incentives to use water more efficiently and which allow flexibility for changing demands and costs of water. For the desired results to be achieved, a long-term strategy of public sector interventions, market solutions, and popular participation should be established and supported through demand management and changing people's behaviour through incentives, regulations, and education. In addition, attention must be given to reallocating existing water supplies to higher value uses, reducing wastages, and promoting water conservation, protection and sustainable utilization as well as modernizing infrastructure, improving management practices, reducing costs, and making delivery of water more efficient. Improvements are needed in water resources infrastructure in Africa, in order to reduce pollution and improve access to, and the affordability and reliability of, infrastructural services (Africa Environment Outlook 2003).

4. Supporting Africa Harness Available Scientific and Technological Knowledge to Solve African Problems

Expanding access to appropriate technologies in Africa is a vital element of ensuring equitable socioeconomic development and a strategy of putting Africa on a more equal footing with the rest of the world in terms of scientific advancement. Science and technology remains the single most important factor that distinguishes the economic leaders and laggards of today (Osama 2006). In Africa, it is still worrying that large areas, particularly rural communities, continue to be marginalised in terms of access to simple appropriate technologies, information and communication technologies and modern technologies.

Proliferation of basic technology such as a simple soap-making and oil pressing machine can help to improve livelihoods through diversifying income sources, employment creation and the development of entrepreneurs. With additional training in commercial production, marketing, distribution and packaging, more goods for both local and export markets can be produced. Similarly, developing basic tools for planning and setting up sustainable agro-enterprises to analyze market opportunities and commodity chains, and to identify those production hurdles that can be best solved through local research can stimulate agricultural dynamism.

These are just a few examples of appropriate technology and much need to be done to identify and promote access to appropriate technologies in Africa where the majority of the people lack

robust economic growth and technology diffusion has failed or is taking place at a very slow pace. This failure is attributable partly to institutional barriers to technology diffusion and technical change among other factors related to lack of funding, poor networking between technology development agencies and scientific research institutions. In addition, slow technological change in Africa is also a result of the absence of or poor science and technology policy that aims at promoting access to appropriate technologies for economic development.

Added to this, is the lack of well-equipped school laboratories, lack of trained science teachers and other learning materials necessary for children and parents to appreciate science and technology. Vocational training centres are also poorly funded. This has made it difficult for simple appropriate technologies to be developed to help communities in such basic yet vital areas as collecting water from wells and improving farming mechanisation.

Improving access to appropriate technologies in Africa will help stimulate development and prevent further marginalisation of the African continent in terms of global scientific and technological development. It can also help bring rural communities closer to their mainly urban elites who have access to Internet, water, electricity and other technologies. Rural areas are endowed with natural resources that can be tapped using appropriate technology to improve the livelihoods of the people (Tsiko 2007).

In rural Africa examples are abound of successful entrepreneurs making it through working on projects that include soap-making, bee-keeping, pottery, stone carving sculpture, oil processing, peanut butter making, shoe and leather products, cloth and craft making, construction, carpentry, welding and other projects. Unfortunately, accessing appropriate technology for such kinds of work is expensive and very few people can afford it. Consequently, it becomes imperative for development agencies to put concerted efforts in facilitating easy access of such technology by committed individuals willing to work hard to transform their livelihood.

In addition to availability of appropriate technology, it is essential to establish technological centres that provide regular training and capacity building in developing business plans, marketing strategies and business management, based on existing and new appropriate technologies. Where businesses are established using simple technology, positive ripple effects on the economy are often observed. Such changes in the economy often transform the level of gross domestic product and influence incomes. On the other hand, most African economies are agricultural based, unfortunately access to appropriate technologies necessary for storage, processing to increase commercial value and prolong shelf life is often non-existent. As a result, valuable farm products are often lost to poor storage and post harvest pests.

The bottom line is, there is an urgent need to support Africa economic development through research, developing, harnessing and transferring new and existing appropriate technology. Investing in appropriate technology and training of people can raise future standards of living and reduce dependency on the natural environment for servival thus mitigating environmental degradation in the process. Also there is need to build capacity in Africa and address social factors and dynamics in development to enhance the transfer of innovation and technology. In addition, measures to ensure project sustainability, building partnerships with existing private sector to help impart technical and business skills and support from development partners and academics can help transfer technology in Africa.

There is no doubt that appropriate technologies can offer practical solutions to a myriad of problems facing people in Africa (Tsiko 2007) and enhance economic growth. With appropriate technology, Africa economic growth can witness a sustained rise in production of goods and

services. But this should be closely linked to investments in human and physical capital, research and development, technological change, and improved institutional arrangements and incentives. Economic growth can be the primary vehicle for alleviating poverty and raising standards of living, subsequently mitigating environmental degradation and desertification as dependency on natural resources by the poor is reduced over time.

5. Generating a Critical Mass of Technological Expertise in Targeted Areas That Offer High Economic Growth Potential and Sustainable Environmental Management

While sectoral diversification is critical to Africa's economic progress, agriculture remains the foundation on which that future will be built in addition to guaranteeing food security. Renewed investment in African agricultural development is essential. But there are major hurdles to overcome. These include poorly developed channels for information on market opportunities and prices, inadequate roads and transport, high input prices, bottlenecks in seed-production systems, low capacity for bio-tech engineering of quick growing, drought tolerant plant species, among others.

Also, a unique development narrative in which science, technology and innovation are often viewed in negative terms has marked the history of Africa. Reactions to new technologies tend to focus first on their dangers before considering their benefits to society. Today Africa clearly view science and innovation as critical to Africa's human development, global competitiveness and ecological management. This pragmatic approach involves a focus on local problems, identification of technological solutions and management of the associated risks (Juma 2006). Africa has resolved to promote programmes that generate a critical mass of technological expertise in targeted areas that offer high growth potential from biotechnology and harness biotechnology in order to develop Africa's rich biodiversity and improve agricultural productivity.

Developing technological expertise in targeted areas that offer high economic growth potential and sustainable environmental management offer some opportunities on how Africa can successfully navigate a changing world, and develop its economy. Africa must heavily invest in science and technology and build the requisite capacity to harness new technologies to grow companies, jobs and industries. Innovation and entrepreneurship stand as the twin pillars of the world's largest economies. Technological innovation is critical to Africa for many reasons. Technology fuels sustainable economic expansions, creating jobs that allow accumulation of wealth, producing quality exports and sustain a robust productivity growth that is critical for the long-term global competitiveness. Technology-based innovations also improve the quality of life, helping people to live longer and enhance agricultural production with fewer chemicals.

In that regard, biotechnology could hold particular promise for African countries, for poverty alleviation and for combating desertification and sustainable environmental management and for economic development. However, despite considerable progress during the past few years, many African countries have been unable to achieve sustained gains in agricultural productivity and economic growth. Food security, nutrition, healthcare and environmental sustainability are among Africa's biggest challenges. Increasing farm productivity will increase food security, provide requisite raw material for urban industrial manufacturing sectors, subsequently supporting economic growth and raising the incomes of the poor. Raising agricultural productivity is critical

in any effective strategy for achieving sustainable economic growth, poverty alleviation, combating desertification and sustainable environmental management in Africa.

Biotechnology provides unique opportunities to increase the quantity, quality and reliability of food supply (Larson 2000). These gains can be achieved with potentially less need for pesticides and herbicides, less demand on scarce water supplies and less pressure to use ecologically sensitive land. Notwithstanding its great potential for good, agricultural biotechnology faces formidable challenges and an uncertain future. These challenges are not primarily scientific or technological; rather, they are essentially political.

For Africa these challenges facing biotechnology can be formidable given that countries lack the technological capacity to guarantee food safety, develop sound, scientific-based food regulatory regimes, undertake comprehensive view of biotechnology on the environment, undertake risk assessment and management and do not have the capacity to use biotechnology to address their pressing developmental needs. Countries recognize that biotechnologies should be developed with appropriate safeguards in place and according to the best internationally agreed standards.

Subsequently, priority areas in biotechnology that are of relevance to Africa's development include among others identification of critical capabilities needed for the development and safe use of biotechnology, establishment of appropriate regulatory measures that can advance research, commercialization, trade and consumer protection and the setting of strategic options for creating and building regional biotechnology innovation communities and local innovation areas in Africa (Juma and Serageldin 2007).

Africa's ability to effectively use existing and emerging biotechnologies will depend largely on the level of investment in building physical, human, institutional and societal capacities placing emphasis on competence-building. Investing in critical capabilities is central to Africa's ability to benefit from its resources. Africa needs to focus on creating and reforming existing knowledge-based institutions, especially universities, to serve as centres of diffusion of new technologies into the economy.

It is imperative for Africa to develop and expand national and regional human resources development strategies that include a continental biotechnology curriculum that offer high economic potential for the countries and the continent, a consortium of identified and designated universities and research centres that develop and offer regional biotechnology training courses and a focus on female recruitment in the sciences and engineering. But to succeed in the face of today's growing challenges Africa need extraordinary efforts from industry, educators, researchers and policy makers. More than ever before, getting the policy environment "right" will be critical to building and sustaining Africa's economic growth, innovative capacity and global competitiveness.

Also, it is critical for Africa to immediately expand and create infrastructure development programmes and be prepared to tap into the opportunities that may arise from biotechnology. Thus, it is very necessary to aggressively promote research, innovations and developmental activities and to establish linkages with both domestic and external research networks. Going forward, the nations with the most competitive technology-based economies will be those whose policies promote innovation, support entrepreneurship, and make sustained investments in scientific research and talent. And that is why Africa needs to build its business, scientific and thought leaders.

It is further essential for African countries to identify specific biotechnology priority areas that

offer high potential for economic advancement and integrate these priorities into development policies. In addition, the creation of partnerships at the local, regional and international levels and policy instruments that enable business incubation and development as well as the development of functional market infrastructure for economic development and stressing the role of technology in small and medium enterprises development policies to improve commercialization and business capacity become imperative.

Africa is ill positioned for a world of high technology right now compared to other nations, other continents are rapidly gaining and pressing their own comparative advantages. The future will be global, hyper-competitive, technologically intensive, and rapidly changing and Africa must be prepared.

6. Building Capacity for Developing New Technology, and Promote Technology Transfer

In most cases, adequate technologies already exist, but unfortunately, not necessarily in Africa where they could best be used to mitigate or adapt to the effects of desertification and drought. Satisfying economic development and sustainable environmental management and utilization in Africa will require radical technological changes. Economic development is needed in Africa but it will not be sustainable if past polluting trends of industrialised countries are maintained. Rapid development with modern knowledge offers many opportunities to avoid bad past practices and move more rapidly towards better technologies, techniques and associated institutions.

The adequacy of any technology in support of Africa development can present some formidable challenges in the context of sustainable development agenda and the problem of development choices. Technologies that may be suitable in one context may not deliver the desired results in another, making it important to ensure that transferred technologies meet local needs and priorities, thus increasing the likelihood of their effectiveness. Although local needs and priorities may be challenging to ascertain by the consensus of the relevant stakeholders, transferring technologies that are to meet such needs without causing a huge economic burden to the people is even more complicated.

Governments in Africa should play direct roles in technology transfer and in creating favourable conditions for the development of appropriate technologies that meet the needs for both economic development, sustainable environmental management, mitigation and adaptation to the changing climatic patterns. Governments should also enact policies that lower costs and stimulate demand to realise environmental benefits that are not adequately produced otherwise. In tandem, integrating human skills, organisational development and information networks become key for effective technological development and technology transfer.

Technology transfer must be a result of many day-to-day decisions, and many stakeholders participation in the decision-making process regarding strategy, investment, international trade, market opportunities, etc. The decisions taken should consider social, economic, political, legal, and technological factors that influence technology transfer reflecting in the process cultural preferences, consumers' awareness, social values, lifestyles, competition, economic sustainability, and environmental sustainability etc.

Given the intricate linkages between economic development, environmental management, desertification and drought issues, technology transfer, should encourage development that is environmentally and climatically friendly (mitigation) and climatic responsive (adaptation),

taking into account the need to adjust to the effects of desertification and climate change. While Africa needs to acquire new and existing technology, it should mostly target technologies that protect the environment and are less polluting, use all resources in a more sustainable manner, recycle more of their wastes and products, handle residual wastes in a more acceptable manner, and are compatible with national socio-economic, cultural and environmental priorities.

Currently, Africa requires both soft technologies such as capacity building, information networks, training and research and hard technologies that include equipment and products to control, reduce or prevent anthropogenic emissions of greenhouse gases in the energy, transportation, forestry, agriculture, industry and waste management sectors etc.

But to achieve adequate technological transfer, Africa will require assistance with developing human capacity (knowledge, techniques and management skills), developing appropriate institutions and networks, and with acquiring and adapting specific hardware. Networks are critical for market creation given their contribution to learning, specifically to the generation of a broad social pool of knowledge related to the capital good in question (Teubal et al, 1991). Technology transfer must therefore operate on a broad front covering these "software" and "hardware" challenges, and ideally within a framework of helping to find new sustainable paths for economies as a whole. The bulk of technology transfers occur within the countries that generate them. The transfer of technologies from the countries and companies that developed them to African countries and entities that could put them to good use has yet to be enhanced.

The need to support developing countries with technological transfer was identified in Agenda 21 of UNCED (1992), a vision for the 21st Century based on the concept of sustainable development. Chapter 34 of the Agenda, on the *Transfer of environmentally sound technology, cooperation, and capacity building* called for access to scientific and technical information, promotion of technology transfer projects, promotion of indigenous and public domain technologies, capacity building, intellectual property rights, and long-term technological partnerships between suppliers and recipients of technology. It was noted that technology cooperation involve joint efforts by enterprises and governments, both suppliers of technology and its recipients. Therefore, such cooperation entail an interactive process involving government, the private sector, and research and development facilities to ensure the best possible results from transfer of technology.

7. Enhancing Rural Economic Viability & Poverty Reduction

Developing countries affected by desertification face many challenges relating to sustainable economic development. Over the past few decades, the environment in Africa for example, has continued to deteriorate. Thousands of people died from starvation brought about by desertification (UNCCD 2004) and poverty. Millions more people are faced with imminent disaster because their water sources are running dry, their land has become so denuded that they cannot rear livestock, and the soil has become so poor that they cannot cultivate it (Conserve Africa 2006).

Poverty and severe environmental problems like desertification, soil erosion and declining soil fertility, deforestation, pollution of water supplies, and biodiversity loss are everyday, real and critical concerns to the people in affected countries (Conserve Africa 2006). Poverty and population pressures have exacerbated desertification and the unsustainable management and utilization of natural resources.

Africa alone for example, with the world's fastest growing population, averaging about 3% a year, will be home to more than a billion people by the year 2025. With the continent's population growth rate ranking highest in the world and therefore placing additional strains on all systems (UNEP 2002) extreme poverty will remain an alarming problem where, there were 58 million more poor people in 1999 than in 1990 (FAO/IFAD/WFP 2002).

Many external challenges also hinder sustained economic development and poverty eradication in affected developing countries, most notably the paralysing indebtedness of many of these countries, the glaring inequity in the terms of North-South trade and the problems of access to technology (FAO 1994). Large external debts of many developing countries are a major concern and many of the same countries have growing 'environmental debts' where the cost of remedial action will be far greater than preventive action (Conserve Africa 2006), thus further worsening, desertification, poverty and the underdevelopment of their economies. Consequently, international funding for combating desertification, poverty eradication and agricultural development needs to rise to a scale commensurate with the problem and be advanced under affordable terms and conditions which do not lead to increases in developing country indebtedness (FAO/IFAD/WFP 2002).

Also, resources, in the programmes of the international financing institutions as well as in those of many bilateral development partners (donors) directed towards combating desertification, poverty eradication, agricultural and rural development, especially in those very countries mostly affected by poverty and desertification are declining (FAO/IFAD/WFP 2002) in spite of reiterated commitments to expand investment in these areas.

In addition, national budgets tend to be directed to satisfying the needs of urban centres at the cost of funding and services for rural areas. This urban bias and rural neglect has led to decreasing levels of economic development, high levels of unemployment, and low generation of real income in the rural areas, thus exacerbating food insecurity, poverty and further desertification as the poor exploit the natural environment for survival.

On the other hand, the desertification phenomenon is serious, because low productivity coincides in many countries with a rapid population increase, and hence an increased demand for food, fibre and fuel (FAO 1993). As a result, the poor often farm degraded land that is increasingly unable to meet their needs and thus, desertification becomes both a cause and a consequence of poverty. Fighting desertification must, therefore, be an integral part of wider efforts to eradicate poverty and ensure long-term food security.

Around the world impoverished people in affected countries face enormous challenges. Not only do they confront limited economic opportunities and underdeveloped markets, but they also tend to have less access to public infrastructure and services such as health, sanitation and education (IFAD 2001), and are less able to engage in advocacy with decision makers. Resource pressure and environmental degradation create additional challenges to affected communities and their livelihoods, exacerbating conflict prone situations and accelerating rural-urban migration flows (FAO 1993).

Broad improvements in human welfare will not occur unless poor people receive wider access to affordable, better quality services in health, education, water, sanitation (IFAD 2001), and electricity. Without such improvements in services, freedom from illness, hunger and illiteracy - the most important ways poor people can escape poverty - will remain elusive to many (Wold Bank 2004). Satisfying the needs of the poor communities will be risky and provisional if land resources are not improved and rehabilitated; land and resource management will be hampered if

people's needs are unfulfilled (FAO 1993). Consequently, desertification control can only be successful if the social, economic, cultural and political development policies adopted aim principally at solving problems brought about by poverty in such areas of food supply, accommodation, employment, income, health, education and population pressure.

8. Creating Alternative Livelihoods

It is a fact that sustainable human wellbeing is intricately linked to sustainable land management and environmental wellbeing and can only be achieved with the simultaneous development of economies that provide alternative livelihoods, which reduce dependents on the natural environment by the affected population. There are interactions between land degradation/ desertification and the propensity for poverty entrenchment, precarious food security, violent conflicts and underdevelopment of the economy particularly so when the land constitute the principal capital for economic development and poverty eradication.

The degradation of land and the natural environment contributes to human wellbeing problems at all levels. More precisely, desertification induces adverse changes in land and environmental quality and resource availability that undermine economic development, threaten the human wellbeing predominantly in developing countries affected by desertification and drought. With increasing poverty, the majority of the population in the developing countries affected by desertification, particularly in rural areas, depend on the natural environment for survival as an adaptation mechanism.

It should be noted that countries have vastly different capacities of dealing with issues of use and ownership of natural resources and the challenges presented by land degradation and desertification. Many affected developing countries do not poses the requisite technological, economic, and institutional resources that would enable them to deal effectively with various crises that may arise as a consequence of land degradation, desertification and the subsequent loss of arable land by the rural population

However, there are a number of mechanisms that could be taken advantage of and contribute effectively to strengthening affected people's adaptation to the effects of desertification. There are measures concerned with alternative livelihoods to reduce pressure on resources and alleviate poverty; and also, there are measures that concern conservation and management of local natural resources, in particular land and vegetation (Eriksen 2001).

In many areas of the drylands prone to desertification and drought, current livelihood and resource-use systems are not able to maintain sustainable human and environmental well being. In most drylands areas, the traditional livelihood systems based on agro-pastoral systems are often inadequate and unsustainable, particularly in view of the effects of drought and increasing demographic pressure. Poverty is a major factor in accelerating the rate of degradation and desertification. Action is therefore needed to rehabilitate degraded lands and improve the agro-pastoral systems for sustainable management of the natural environment, as well as developing sustainable alternative livelihood systems.

The World Summit on Sustainable Development (WSSD) of September 2002 reaffirmed land degradation as one of the major global environment and sustainable development challenges of the 21st Century. It called for concerted efforts to address the causes of desertification and land degradation to restore the viability of the land, and eradicate poverty emanating from land degradation.

Among the basic problems to natural resource management in rural areas is the population pressure on these resources combined with the poverty situation in which marginalised groups find themselves in, given the limited alternative industrial activities to reduce pressure on land (UNEP 1995) particularly in rural areas. A general lack of alternative development opportunities leads rural communities to encroach on the natural resource base in an often illegal, uncontrollable and unsustainable manner.

Furthermore, the declining terms of trade on agricultural commodities add pressure on land and contribute to continuing poverty. Engaging in alternative income sources is an important desertification response among rural households. Therefore, the management of the natural resource base not only involves effective control mechanisms, but it also involves the development of viable economic alternatives to unsustainable use.

The development of rural economies and eradication of poverty is most imperative if overall economic development and the sustainable management of the environment and natural resources have to be achieved. As indicated above, in the rural setting there is need to develop economic alternatives for the rural poor that see themselves forced to encroach on the natural resource base. At the same time, rural industrial development and investments must take due consideration of their possible impact on the environment.

Promoting alternative livelihoods that do not depend on traditional land uses and are less demanding on local land and natural resource use, yet providing sustainable economic returns have the potential to reduce desertification in the drylands ecosystems. This can be done through promoting other forms of natural resource based private sector development initiatives such as eco tourism, ethical trading of agricultural produce and the controlled commercialisation of forest products. Other specific livelihoods could include dryland aquaculture for production of fish and greenhouse agriculture as well as undertaking income-generating activities in cottage and agro-processing industries, adding value to farm produce.

Such alternatives have the potential to generate relatively high-income returns per land and water unit. For example, a well-maintained natural heritage also benefits the tourist industry and the quality of life for those who live on, work on or visit the countryside. If managed effectively, tourism can bring significant benefits for the environment itself. Tourists visiting natural heritage sites for example can provide requisite funds and support needed for the sustainable management of the respective sites and the natural environment attached to these sites.

Consequently, governments need to create, expand and diversify the economic structures throughout the rural sectors. Efforts may focus on policies for developing institutional infrastructures that enable rural industrial development, provide the right atmosphere for business and enhance viable alternative livelihoods. Measures should further aim at improving the education system to enable it to respond to the complex skill and human resources needs for rural industrialization.

Unfortunately rural areas often lack all basic services and functioning infrastructure, while income-generating opportunities are scarce and poverty is rampant. The development of alternative livelihood projects can only work as part of a wider multi-sector alternative development package, requiring massive, holistic and long-term investment and commitment throughout the rural areas of the drylands where the natural environment is threatened by land degradation and desertification

Support to rural industrialisation should include establishing and strengthening industrial research and development institutions and other institutions that support small- and medium-sized industries as well as improving financing conditions for industrial projects by creating and or expanding financial institutions activities in the rural areas. The establishment of alternative livelihoods should be supported by adequate financial resources to enable the revival of business in the event of temporary closures that could be a result of technical reasons or continuous loss. Some alternative livelihoods may require the strong involvement of interested professional management by established private companies or individuals in order to sustain the venture.

Also, a number of pertinent issues that may determine the success or failure of establishing alternative livelihoods in rural areas should be taken into account. These may include the time taken and the costs of establishing the infrastructure facilities, the number of local people involved or employed in the established ventures and the viability of their regular wages, the existence of permanent markets that absorb the produced goods and services, the net profit generated and how much of it is returned by the community involved in these commercial enterprises and degree of ownership by the communities. Where the local population wholly owns enterprises, the interest of the community in taking ownership of the venture should be enhanced for sustainability to be achieved in the long term.

Also risks that may be presented by uncertainty of availability of sufficient raw material, unavailability of permanent market linkages as well as fluctuating market prices and technical issues involved in the maintenance of equipment should be minimised. At the same time increasing the managerial and technical skills of the involved local communities is pertinent, particularly so when the entire infrastructure including machinery would be returned by the rural population.

The establishment of alternative livelihoods in the drylands often provide a competitive edge over those outside the drylands, since they harness dryland features such as solar radiation, winter relative warmth, brackish geothermal water, and sparsely populated pristine areas that are often more abundant than in non-drylands. Implementation of such practices in drylands requires institution building, access to markets, technology transfer, capital investment, and reorientation of farmers and pastoralists (MA 2005).

For many years to come agriculture will remain a major contributor to the economies in most developing countries, although its potential may progressively decline as desertification takes its toll. The decline in economic returns from the land necessitates the employment shift from agricultural to off-farm sectors of the rural economy.

Already agriculture is not offering sufficient opportunities for gainful employment, leaving millions of economically active members of the populations redundant. The limited employment opportunities in most rural communal areas of developing countries have enhanced disparities in the living conditions of rural dwellers, and between rural and urban populations.

While the prosperity of rural economies is rooted in long-term investment in agriculture, measures should be taken to enhance viable economic alternative livelihoods to reduce the rural population dependency on agricultural production, diminish pressure on land resources, enhance overall economic development and alleviate poverty. Also such measures should enhance the conservation and management of local natural resources, in particular land and vegetation.

Efforts to establish realistic, alternative livelihood projects need to address the needs of small farmers to maximise their subsistence possibilities while reducing their poverty levels. But they also need to address the profit-maximising desires of the private investor who may be harder to persuade to invest in rural areas.

Engaging in alternative economic livelihoods is an important measure for enhancing the development of both the rural and urban economies and reducing pressure on the land resources and the natural environment. For many concerned with poverty reduction, development of alternative livelihoods help and encourage people dependent on degraded resources or overcrowded ecosystems to improve their lives. But the process of generating viable and sustainable alternatives is not an easy or straightforward task. Thus policy measures are required to help facilitate the generation of off-farm income opportunities, and provide unreserved support for the development of the rural economies to reduce pressure on the land resources and the natural environment.

However, there exist hard realities that establishing realistic alternatives could be elusive and unattractive when not well thought through. Alternative livelihoods must reduce the dependency on the natural environment for survival through providing incentives towards different economic options and creating rural employment.

Consequently consulting people living in rural areas of the drylands is pertinent for creating the capacity of village communities and pastoral groups to take charge of their development and the management of their land resources on a socially equitable and ecologically sound basis for establishing sustainable alternative livelihoods. Initiatives should also emphasize multiple stakeholder ownership, local participation and public involvement. Findings of the stakeholders' consultations must constitute key inputs into the bases for developing and establishing sustainable alternative livelihoods.

Concerted efforts should be made to undertake industrialisation in rural areas to enhance rural economic development. Recognition of the non-farm informal sector supporting industrialisation in rural areas and their neighbourhoods and the introduction and use of technologies for the generation of alternative sources of incomes would be imperative for the development of the rural economies. Promoting alternative livelihood opportunities, particularly through development of employment schemes that increase the productive base, will have a significant role in improving the standard of living among the large rural population.

The rural industrial and agricultural sectors should not be perceived as entities independent of one another but should compliment each other and strengthen existing and new rural off-farm household activities. All forms of rural income-generating activities, such as sustainable tourism, fisheries and environmentally sound mining should be promoted and infrastructure and social services must be improved at the same time the livelihoods of local communities should be protected.

Increased rural industrialization and economic development provide opportunities for alternative livelihoods and reduces the rural communal population dependents on land and the natural environment for survival as well as allowing accumulation of wealth and poverty eradication particularly for rural populations, thereby improving their standard of living. It is a fact that accumulation of wealth and poverty reduction reduces the dependency of the population on the natural environment for survival. Also accumulation of wealth and eradication of poverty

enhances the overall economic development and allows the population to invest adequate resources in sustainable natural resources management.

Strengthening alternative sources of income, enhancing rural economic development and increasing employment opportunities enhances wealth accumulation and reduces environmental degradation as human wellbeing is improved. That being the case, it becomes apparent that the development of rural economies and eradication of poverty is most imperative if overall economic development and the sustainable management of the environment and natural resources have to be achieved.

Consequently, sustainable management of local resources should not be about protecting and enhancing the natural environment through careful planning and responsible practices only. Concerted efforts should be made to increase wealth accumulation and poverty eradication through the establishment and development of local, national and inter-sectoral mechanisms that address imperatives associated with access to land, ownership and security of tenure, to enhance rural alternative livelihoods, sustainable environmental management and economic development initiatives. Particular attention should be given to protecting the property rights of women and indigenous population to enable their effective participation in rural economic development.

Strengthening alternative sources of income should be closely linked to conditions for tackling rural poverty, to be successful. It needs to be accompanied by a host of other reforms, in the marketing of produce, technical assistance and necessary infrastructure such as roads, bridges, schools and clinics to achieve the desired results of economic development and poverty eradication. Setting up rural credit systems, mobilizing savings through the establishment of rural banking systems and creating revolving funds for advancing low cost credit to rural entrepreneurs and local groups and the establishment of rural industries and business ventures are equally fundamental for the sustainable management of natural resources. In addition, there is need to expand education and training aimed at building gender equality, building capacity for sustainable land management for increased agricultural production and enhancing economic development through creating non-farm employment to enhance sustainable economic development that lead to accumulation of wealth and eradication of poverty.

Additional measures for strengthening rural alternative sources of income and capacity building may include the creation and strengthening of local level groups focused on economic activities of common interest such as market gardening, bee keeping and honey production, transforming and adding value to agricultural products, commercial livestock keeping, developing rural economic infrastructure such as access roads to urban markets, providing appropriate storage facilities for perishable farm products, skills training and

micro-business development etc. Such initiatives should be supported through improving both the quality and quantity of rural products and building adequate marketing capacity, by involving the local people to promote alternative livelihood systems and alleviate poverty.

While the inhabitants of the rural areas, supported by governments at the appropriate levels have the pivotal role in developing sustainable alternative economic livelihoods, the support of the relevant international and regional organizations is paramount if the desired results are to be achieved. The support of external stakeholders should facilitate the conducting of socio-economic baseline studies to gain the requisite understanding of the situation on the ground related to local resource and land tenure issues, traditional land-management practices and characteristics of the prevailing economic production systems. Information on the state of the

natural resources such as soil, water and vegetation cover and their state of degradation should be obtained based primarily on the knowledge of the local population.

Measures should be taken to facilitate information dissemination on the development of alternative livelihoods within and across regions of the drylands as well as to promote cooperation among the arid and semi-arid land research institutions developing appropriate techniques and technologies that improve land and labour productivity, as well as viable economic production systems that enhance rural economic development, sustainable environmental management and poverty alleviation.

In addition, the implementation of programmes and projects directed towards the alleviation of poverty and promotion of alternative livelihoods with the support of international organizations and non-governmental organizations should be efficiently coordinated and harmonized to achieve sustainability. Alternative livelihoods help and encourage people dependent on desertified dryland ecosystems to improve their lives. Establishing sustainable rural economic production and marketing systems as well as building robust processing capacities will in the long term, help create income-generating alternatives that will contribute to gradually reducing dependence on the natural environment for survival.

But the process of generating viable and sustainable alternatives is not an easy or straightforward task. It won't happen overnight and has its own limitations. In addition, to be attractive to the target beneficiaries, and successful, livelihoods initiatives should take relatively short duration to achieve results. But unfortunately, even if alternative livelihoods initiatives are viable, they often take decades to achieve the desired economic returns, threatening their attractiveness to the affected rural population.

Therefore, understanding how and why rural people are attracted to a particular income generating activities is key to developing effective strategies to support this process. However, these strategies are often poorly understood. Attempts to assist this process tend to be based on only a limited understanding of the factors and forces that are liable to ensure success. The factors that play a role are complex, ranging from the relative productivity of the local area, to levels of risk, security and education, as well as the nature of local production, markets and demand. Notwithstanding, it is clear that the establishment of alternative livelihoods linked to targeted support for the drylands can pave the way for the affected populations to help themselves out of poverty and prevent land degradation and desertification.

9. Adaptation and Reducing Vulnerability to Desertification

The tragic death of thousands of people in the Sahel drought of 1968-1973 (UNCOD, 1977) demonstrates the vulnerability of humans to desertification. As desertification proceeds, agricultural and livestock yields decline, reducing people's options for survival. Furthermore, local people lose the vital ecosystem services that dead trees and shrubs had provided and the loss of firewood, traditional medicine species, and emergency food species render them more vulnerable to future environmental change.

Adaptations to desertification and drought in Africa have involved diversification and intensification of resource use. Africa, farmers traditionally have adapted to harsh environmental conditions by promoting natural regeneration of local trees and shrubs, whereby farmers and

herders seek to reconstitute vegetative cover by setting aside parcels of land or by selecting valued trees in their fields, pruning them, straightening them, and raising them to maturity

Scarce water resources are becoming increasingly critical for Africa as they determine food security as well as human and ecosystem health, and play a major role in political and socioeconomic development. Given the close linkages of desertification to climate change, priority should be given to reducing greenhouse pollution, harnessing of renewable energy and implementing energy efficiency programs in African countries, helping communities prepare for droughts, and reviewing immigration programs for environmentally displaced people.

A few approaches to reducing vulnerability to drought have been suggested in addressing adaptation to the linkages between desertification and climate change. One approach is to reduce the need for household coping strategies, or ensure that harvests fail less often, by increasing the resistance of agriculture to drought and climatic variability. Some preferred coping strategies are successful in enabling households to maintain basic consumption during drought. A second suggested approach is, to enhance household access to preferred or principal coping strategies. A third strategy proposed entails reducing vulnerability through increasing the viability of drought coping strategies to which most households have access. Enhancing household ability to engage in alternative economic activities during drought becomes an important measure for improving climate change adaptation.

Existing measures aimed most directly at adaptation to drought, largely focus on increasing agriculture's drought resistance. Drought-resistant crops are perceived as principal means of addressing problems related to climate variability and drought in particular. Another way of addressing drought vulnerability and reducing the sensitivity of farming to erratic rainfall is to provide agricultural water from other sources. Irrigation and water provision are central concerns, particularly in enhancing rural economic development. Improvement and expansion of irrigation as well as water harvesting are identified as important measures to increase agricultural production. Development of water supply and irrigation for areas of unreliable rainfall should be closely linked to the development of and/ or transfer of affordable irrigation technologies.

Efforts to enhance the drought resistance of agriculture are of themselves unlikely to provide successful local adaptation to climate change. They face several constraints. Farmers are more often than not reluctant to adopt certain drought-resistant species, in part due to low market and consumption values, and in part due to high labour investment associated with cultivating these species. It is likely that successfully increasing cultivation of drought-resistant species requires numerous measures addressing social, economic and technical constraints. In addition, due to high costs, improved food security during drought can only partially be achieved through local efforts to increase water supply. Other adaptations to desertification involve more efficient management of resources. Where farmers have access to credit the tendency is to adopt low-cost, appropriate technologies for wind erosion control, including windbreaks, mulching, ridging, and rock bunds (Baidu-Forson and Napier, 1998).

However, for sustainability, it is critical to enhance seasonal climate forecasting to assist communities at risk to know times of higher probability of success of resource diversification or intensification. Advances in seasonal forecasting, using climate models and satellite observations, has been shown to be a first-order response strategy to changing climate variability. Similar applications of satellite observations also are useful in predicting disease outbreaks. Seasonal forecasts for Africa currently exhibit moderate skill levels but skill levels and user communications are not yet high enough to permit users to confidently implement field applications. There is great potential in investing in seasonal forecasting and development of

tools (models) such as crop models that can be used to make adjustments in management. Models offer realistic response to changing climatic patterns. Data must be collected to calibrate and validate these models. In the longer term, governments will need to develop strategic plans that are based on solid foundations. This is an area that is underdeveloped in almost all of Africa.

Effective communication of predicted extreme weather events and evaluation of potential risks is critical in minimizing human loss of life, where it is possible to react. Disaster management plans are required and need to be developed jointly with all members of a community. On the general adaptive capacity in Africa is influenced largely by the ability to communicate potential risks to vulnerable communities and the ability to react as a result of perceived risks. The ability to mobilize emergency measures is critical in reducing adverse impacts. Although there may be high adaptive capacity locally or nationally, overall most countries in Africa have low capacity to adapt to abrupt and extreme events.

Conclusions

Existing evidence suggest that certain arid, semi-arid, and dry sub-humid areas are experiencing a decline in rainfall and frequent and severe droughts, resulting in further desertification, decreases in soil fertility and agricultural, livestock, forest, and rangeland production. Ultimately, these adverse impacts of land degradation and desertification constitute a major cause of poverty, forced human migration, deadly conflicts, starvation, and destruction of critical habitats, socio-economic instability and climatic variability through reduced carbon sequestration potential, leading to political and socioeconomic instability.

On the other hand, human activities typical of poverty and underdevelopment such as the cultivation of fragile soils, non-utilization of organic or mineral fertilizers, overgrazing, excessive tree cutting for energy-fuel wood, uncontrolled veldt fires, among others cause land degradation and desertification. The major cause of human related land degradation and desertification in the drylands, particularly in developing countries, is primarily poverty because rural areas often lack all basic services and functioning infrastructure, while income-generating opportunities are scarce. Establishing alternative livelihoods provide opportunities for reducing pressure on land resources while at the same time providing additional sources of income, particularly for rural populations, thereby improving their standard of living.

Exploring alternative ‘sustainable’ livelihood strategies in a holistic and participatory manner should be considered a high priority as sustainable livelihoods begin with the ability to exercise control over the natural resources on which one depends. Existing and new rural livelihoods should be systematically integrated into sectoral and national economic development plans and programmes targeting poverty alleviation and sustainable environmental management

The successful management of the natural resources and rehabilitation of degraded and desertified lands to promote sustainable development requires the interventions of major scientific innovations and socio-economic fundamentals and shifts in ecosystem management approaches to overcome challenges related to desertification. Scientific innovations should respond to critical challenges focusing on local problems, identifying technological solutions and managing the associated risks. In addition, building of adequate capacity among stakeholders in management skills and in such special techniques as soil and water conservation, water harvesting, agroforestry and small-scale irrigation becomes pertinent. Such interventions must be implemented at all levels from local to global scales, with the active participation of all key stakeholders.

Given the range and magnitude of development constraints and challenges facing most African nations, poor trade between countries and within regional economic groupings will continue for a long time to come as reflected in low socio-economic growth and the continent's inability to claim a significant share of global trade despite its rich endowment of natural resources. Thus Africa must start strengthening trade within itself and enhance interregional trade.

Expanding access to appropriate technologies in Africa is a vital element of ensuring equitable socioeconomic development and a strategy of putting Africa on a more equal footing with the rest of the world in terms of scientific advancement. Also, developing technological expertise in targeted areas that offer high economic growth potential and sustainable environmental management offer some opportunities on how Africa can successfully navigate a changing world, and develop its economy. In addition, there is great potential to transfer technology to Africa that would help in developing sustainable agriculture, as well as other technologies that would assist in improving welfare and economic development.

The impacts of desertification and drought are expected to be severe in Africa considering the changing climate, yet Africa's contribution to climate change through emissions is minimal. Africa is highly vulnerable, with very low capacity to adapt. Adapting to the effects of desertification and drought in the face of the changing climate offers some opportunities for Africa development. The process of adapting to global climate change, including technology transfer, offers new development pathways that could take advantage of Africa's resources and human potential. Adopting biotechnology can make Africa agricultural products competitive, resulting from research in new crop varieties and increased international trade, and related industrial developments.

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