Lesotho Meteorological Services

Ministry of Natural Resources

ADAPTATION TO CLIMATE CHANGE: TECHNOLOGY NEEDS IN LESOTHO

Energy and Land Use Change and Forestry

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PREFACE

As part of the measures to mitigate the adverse effects of climate change, the United Nations Framework Convention on Climate Change (UNFCCC), calls for all practicable steps to be taken to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to developing countries to enable them to implement the provisions of the convention.
This need to forge scientific and technological breakthroughs is more pronounced in countries that are considered very vulnerable to the adverse effects of climate change, Lesotho being one of such cases. Although the country has embarked on the identification, assessment and development of technologies that promote sustainable development without contributing significantly to greenhouse gas emissions, the barriers to the transfer of these environmentally sound technologies (ESTs) has been found to be insurmountable in some sectors of the economy.

Lesotho is not alone in facing the challenges that are posed by barriers to technological transfer. The problem of lack of technological innovation and development is common throughout the developing world. The current exercise that aimed at assessing the country=s adaptation technological needs, particularly in the energy and land use change and forestry sectors, attempted to unravel some of these barriers. The two sectors in which detailed assessments of technological needs were made were found to be emitting the highest amount of greenhouse gases in Lesotho=s First Communication to the Conference of the Parties to the UNFCCC in April 2000.

This report is in 6 chapters: chapter 1 attempts to summarise the country=s development objectives and conditions that compel Lesotho to embark on technology development initiatives; chapter 2 summarises national experiences with technology development in various sectors; chapter 3 makes an in-depth analysis of the role of education and training in technology development; chapters 4 and 5 attempt to assess technology needs respectively in the energy and land use change and forestry sectors; and chapter 6 presents conclusions and recommendations to be drawn from each of the areas of assessment.

It is hoped that the current report will not only provoke debate around challenges facing the transfer of technology in various sectors of the Lesotho economy, but also pave the path for future interventions. Many thanks go to all those who facilitated the compilation of this report.

Tseliso Sekoli
Director
Lesotho Meteorological Services

LIST OF ACRONYMS

ADB	African Development Bank
ACTS	African Centre for Technology Studies
AGOA	African Growth Opportunities Act
ARD	Agricultural Research Division
ARIPO	African Regional Intellectual Property Organization
ATPS	African Technology Policy Studies
ATS	Appropriate Technology Section
BEDCO	Basotho Enterprises Development Corporation
COSC	Cambridge Overseas School Certificate
CWS	Civil Works Section
DMS	Department of Meteorological Services
DRR	Department of Rural Roads
DRWS	Department of Rural Water Supplies
DST	Department of Science and Technology
DOE	Department of Energy
ESDP	Education Sector development Project
EU	European Union
GCM	Global Circulation Models
GHG	Green House Gas
GMO	Genetically Modified Organisms
GTZ	German Technical Organization
IPCC	Intergovernmental Panel on Climate Change
IST	Institute of Science and Technology
IT	Information Technology
JC	Junior Certificate
LCU	Labour Construction Unit
LEC	Lesotho Electricity Corporation
LEHCoop	Lesotho Housing Cooperative
LHDA	Lesotho Highlands Development Authority
LHLDC	Lesotho Housing and Land Development Corporation
LMA	Lesotho Manufacturers Association
LNDC	Lesotho National Development Corporation
LSPP	Department of Lands, Surveys and Physical Planning
LP	Liquid Petroleum
LUPD	Land Use Planning Division
MADF	Machobane Development Foundation
MAO	Ministry of Agriculture and Food Security
MCC	Maseru City Council
MFS	Machobane Farming System
NCDC	National Curriculum Development Centre
NES	National Environmental Secretariat
NGO	Non-Governmental Organization
NUL	National University of Lesotho
ODA	Overseas Development Administration
PSLC	Primary School Leaving Certificate
PV	Photovoltaic
RET	Renewable Energy Technologies Project
RSA	Republic of South Africa
SADC	Southern African Development Community
SAPP	Southern African Power Pool
TV	Television
TVED	Technical and Vocational Education Department
UNFCCC	United Nations Framework Convention on Climate Change
UNFP	United Nations Fund for Population
VIP	Ventilated Improved Pit Latrine
WASA	Water and Sewerage Authority
WIPO	World Intellectual Property Organization

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1. BACKGROUND

Socio-economic conditions

Lesotho comprises a tiny landlocked country that occupies 30,588km^2 which is inhabited by an almost homogeneous ethnic group. The country is divided into 4 ecological zones: the lowlands (17%), the foothills (15%), the mountains (59%), and the Senqu River Valley (9%). Because of the country=s topography, economic activities are largely confined to the lowlands, the foothills, and the Senqu River Valley, leaving the mountain region only suitable for grazing and, in recent years, for water and hydro-power development. The country is not only resource-poor but is facing dangerous levels of environmental degradation, severe soil erosion, and progressive desertification. Lesotho also experiences very harsh climatic conditions that limit agricultural activities in a sector that supports the majority of the population.

The 1996 census put the population of Lesotho at 1,959,700 people. After dropping from 2.6% in the period 1976-86 to 2% in the period 1986-96, the country=s population growth rate is still considered too high for available resources. The country is still highly dependent on migrant workers= remittances from the Republic of South Africa (RSA), on regional customs union earnings, and on development cooperation resources.

Despite significant progress in the country=s macro-economic performance over the past few years, Lesotho still faces an uphill battle against poverty. Unemployment is still estimated at 30-35%, while 50% of the households are still classified as poor and 25% ultra-poor. There has also been a gradual decline in factor incomes from abroad in recent years as the employment of migrant workers in the RSA declines, mainly due to employment problems in the latter.

Since 83% of the households in Lesotho live in rural areas and 70% derive all or part of their livelihood from agriculture, the contribution of the latter sector is of critical importance in the determination of socio-economic conditions in the country. However, Lesotho=s limited natural resource base, together with a mountainous topography, limited arable land, unreliable climate, and severe soil erosion, are constraining the agricultural sector to generate adequate levels of employment and incomes to support the country=s rapidly increasing population. This pervasive constraint, together with constraints facing domestic employment creation in other economic sectors, places severe limitations on efforts towards the realization of national objectives.

National development objectives

Despite the socio-economic constraints cited above, Lesotho remains committed to its goal of sustainable human development, a goal which broadly encompasses the objectives of poverty alleviation, employment creation, social integration, and land conservation. These objectives have been underlined almost in all official and planning documents.

Poverty alleviation

The biggest constraint to human development in Lesotho is poverty, a pervasive constraint that is closely associated with lack of resources, low productivity, the pursuit of inappropriate development policies and strategies, and the poor international competitiveness of the economy. For Lesotho citizens to take up their rightful places under the Constitution, and to fully participate in all aspects of development, they must be free from hunger, disease, ignorance, and isolation. In this respect, a number of policy reforms have been formulated with a specific objective to effectively deal with the problem of poverty. In addition, a number of programmes are now being reviewed with the aim to maximise their poverty alleviation content.

Employment creation

In a country where over 75,000 people are employed outside their own country in a labour market over which they have little control, where total open unemployment is estimated at more than 30%, and where it is estimated that at any one year, over 22,000 join the labour force, employment creation as a vehicle for stimulating economic growth and development is not only a critical policy objective but a strategy in

poverty alleviation. This development objective has occupied significant portions of the country=s development efforts.

As indicated above, experience in previous initiatives has shown that economic growth alone is not a sufficient condition for the expansion of employment opportunities in the country. For economic growth to have sustainable impacts, it must be accompanied by an expansion of the country=s technological horizons. This has recently been demonstrated in the textiles and clothing sub-sector of the manufacturing sector which is now the major engine of the expansion of employment in the sector (figure 1).

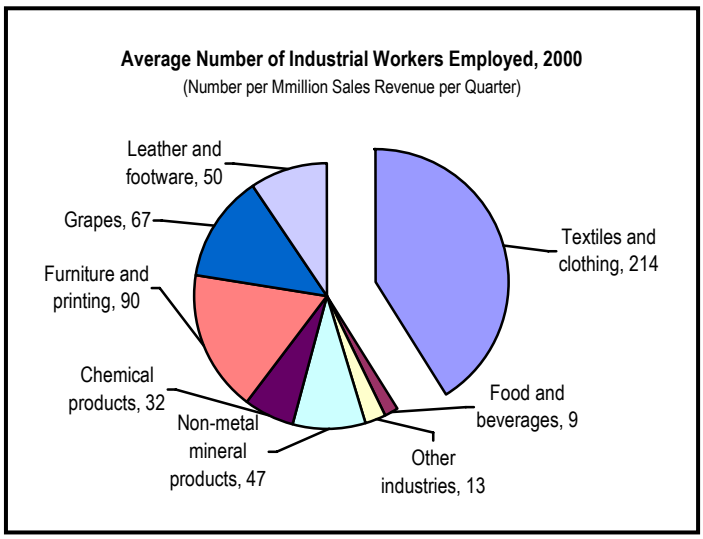


Figure 1

Social integration

Social integration is a critical national objective that calls for equality before the law; protection of community diversity; elimination of all forms of discrimination; equal access to basic services including health, education, water supply, and employment opportunities; and governance that should include taking government to the people through transparent practices, accountability, decentralization of development functions, and by promoting grassroots organizations and opening up avenues for direct participation. Benefits that come with improved social integration are quite varied. They include improvements in the capacity to mobilise local resources, improvements in community organizational and management capability, possibilities for local initiatives, local design and implementation of projects, increased provision of skills and information, and increased local influence on national policies.

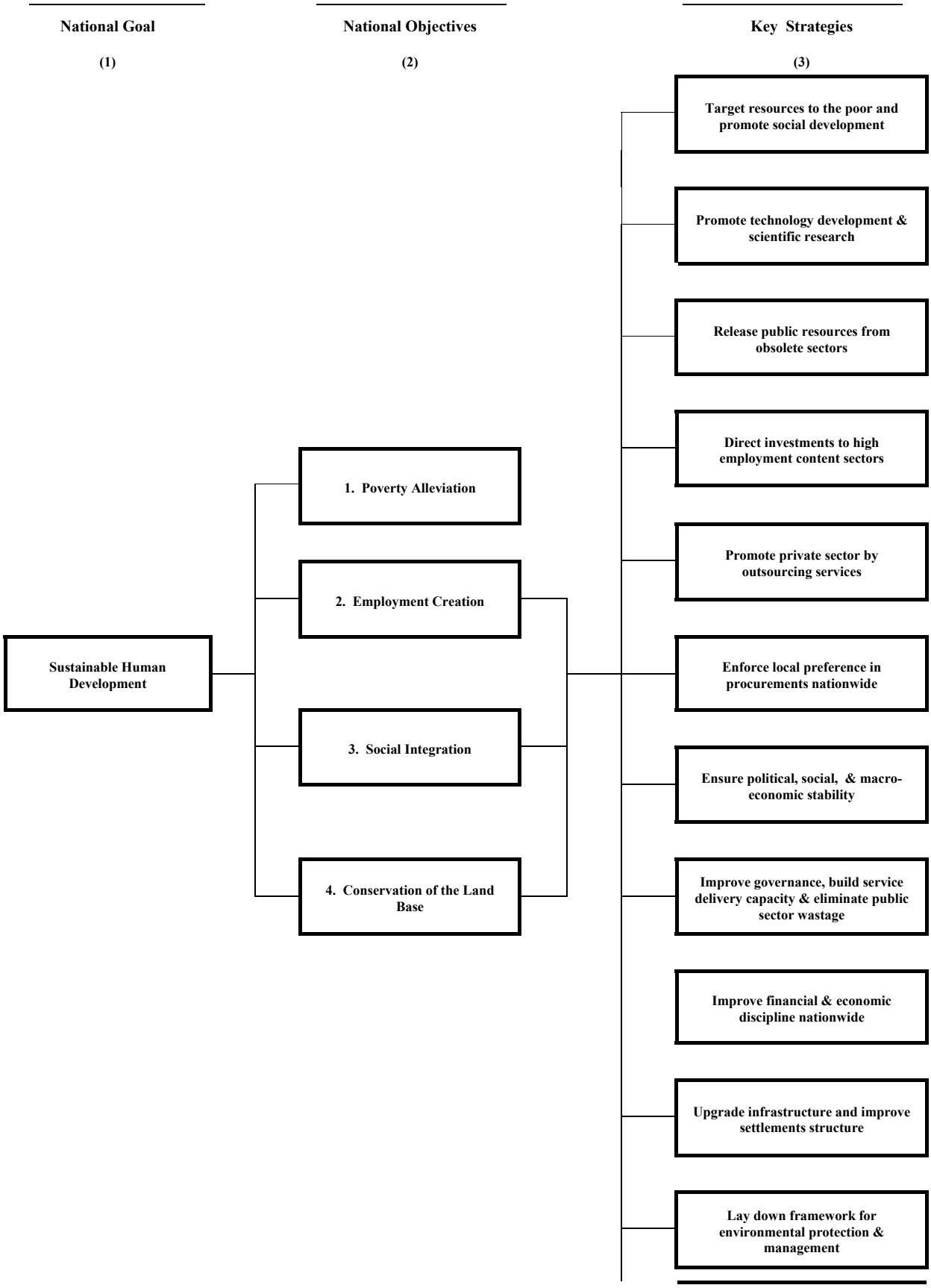
Social integration as a policy objective aims at strengthening civic society, responding to gender demands and those of youth and the disabled, restoration of the public confidence in government authority, improving governance and broadening the national dialogue on critical policies, facilitating social learning, increased attention to local demands and processes, and ensuring the long-term sustainability of development initiatives. In this regard, therefore, Lesotho, suffering high levels of social deprivation, puts a very high premium on this national policy objective that is closely inter-twinned with other objectives.

Conservation of the land base

Since most of the population in Lesotho is directly dependent on the land for survival, there is a clear relationship between the state of the environment and living standards. The country=s environmental problems largely emanate from the escalating negative impacts of the increased exploitation of natural resources as manifest in various forms of land uses - maintenance of large numbers of livestock, collection of firewood, expansion of agriculture and human settlements, etc. These activities, which take place within a communal land tenure system, have contributed to the severe loss of vegetation cover, leading to increased run-off, soil erosion, land degradation, loss of biodiversity, and low agricultural production and productivity, all of which have contributed to worsening levels of poverty, particularly in rural areas.

Diagram 1

The Programming Framework for National Development Objectives



The guiding principles, which derive from *The Constitution of Lesotho*, include the fundamental right to a healthy environment, the use and conservation of the environment and natural resources for the benefit of both present and future generations, preservation of the biodiversity, reclamation of lost ecosystems, and, where possible, reversal of degradation, and the establishment of adequate environmental standards and monitoring of the same.

It is hoped that the conservation of the land base will lead to environmental recovery, which in turn will lead to increased productivity, higher levels of employment, and lower levels of poverty. Lesotho recognises that this is one of the preconditions for sustainable human development.

The future path of development

Lesotho=s future development path has been mapped out in a document that was formulated by national representatives through a national dialogue in January 2001. This document, which represents a national vision statement, affirms that Aby 2020, Lesotho shall be a stable, democratic, united, prosperous nation at peace with itself and its neighbours. It shall have a healthy and well-developed human resource base. Its economy will be strong, its environment well managed, and its technology well established@.[1] The strategies that are set out for each national development objective in the vision statement are summarised into a log frame on diagram 1 above.

The role of science and technology in development

Although there is general acknowledgement that science and technology form the basis for all forms of development, the use of technology for economic development is still young in Lesotho. Consequently the benefits of technology in general are not yet fully appreciated due to lack of knowledge. The government recognises that A*science and technology* is one of the key building blocks of an economy in the current global economic order and in the foreseeable future@.[2] This comes from a realization that countries that have built strong technological foundations for development have found that such investments result in:

- Longer-term economic sustainability;
- The creation of opportunities to develop new products;
- Increased competitiveness and business advantage in the global economy;
- The creation of an appropriate environment for sound decision-making; and
- The creation of an appropriate framework for environmental rehabilitation.

There are other imperatives that compel Lesotho to formulate and adopt strategies for technological development. These emanate not only from unacceptably high levels of poverty and unemployment as has been reiterated above, but from the country=s agro-ecological conditions as well as from results of projections of future climate change scenarios. Despite efforts to address these problems through technology development, there are severe constraints, some of which are of a historical and cultural

[1]Ministry of Development Planning, (January 2001) **Report of the National Development of a National Vision for Lesotho**, Maseru

[2]Hon T. T. Thahane, (16 February 2004) **Continuing to Build Foundations for Delivery of Services to the People: Budget Speech to Parliament for the 2004/05 Fiscal Year**, Parliament of the Kingdom of Lesotho, Maseru

nature. Previous technology development efforts have also been hampered by the absence of a consolidated national policy.

Agro-climatic conditions

Lesotho=s agro-ecological conditions paint a gloomy picture where arable land not only constitutes a mere 9% of total land area, but is known to be gradually shrinking due to severe soil erosion and land degradation. There is also a growing food deficit as both agricultural production and productivity are undermined by growing animal and human pressure, poor land management practices, and adverse weather conditions. Crop cultivation is limited to a narrow belt in the western lowlands and foothills. The high altitude plateaux and mountains are mainly suitable for grazing.

In general, weather patterns that result from the interaction of physiographic features and the combined influence of the Indian and Atlantic Oceans reduce the duration of the growing season in Lesotho, and place severe limitations on potential crop/land productivity by limiting the adaptability and distribution of different types of crops that can be grown in the country, as well as different cultivars within each crop type. This is particularly the case during the winter season. For example, during the cropping year 2000/01, the total area planted with crops dropped from 353,004 hectares in summer to a mere 19,942 hectares in winter.

As a result of agro-ecological limitations, and of large capital outlays that agriculture in the country calls for today, production for the market has mainly been limited to producers of traditional products such as wool and mohair, to a handful of rich peasants who produce grain crops mainly on a share-cropping basis, and to very few enterprising poultry and vegetable farmers, usually retired civil servants or retired migrant workers, who have the necessary capital to invest. The vast majority of the farmers in Lesotho no longer take agriculture as a full-time activity.[3] They produce mainly for subsistence, selling occasionally to meet emergency needs of the households.

In order to realise a marketable agricultural surplus in Lesotho, it is essential that the full genetic potential of each livestock category or crop cultivar is realised by ensuring that it is reared or grown under conditions that are as close to ideal as possible. In this regard, the government has been actively engaged in livestock genetic improvement programmes and in the development of a comprehensive reference for all field crops and vegetables, using the characteristics of the agro-ecological regions and data from soil surveys. Other strategies have included adaptive research and opening up twinning arrangements with other research institutions in the sub-region.

With current agro-ecological conditions, it is clear that as long as Lesotho=s population continues to increase and soil loss accelerates through soil erosion, there will be an increasing burden on the government to ensure that the remaining arable land is used more productively, hence the emphasis on technological development.

Climate change scenarios

A number of climate change scenarios for Lesotho were generated with the assistance of six global circulation models (GCMs) using historical data for the years 1961 to 1994.[4] The future climate conditions that were predicted by these different GCM climate change scenarios showed that by 2075, Lesotho was likely to be a warmer country with less precipitation, particularly during spring and summer months. The lower yield in both surface and ground water that goes with this finding indicates that the country could experience an absolute water scarcity by 2045 unless bold adaptation strategies were adopted.

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[3]This disinterest in agriculture has also been observed in some rural areas in the RSA (Carol Paton, (August 4, 2002) ***Ties to the Land no Longer Bind***, **Sunday Times: Insight**).

[4]Ministry of Natural Resources (April 2000) **Lesotho: National Report on Climate Change,** First National Communication to the Conference of the Parties to the United Nations Framework Convention on Climate Change, Maseru.

These future climate change scenarios, whether positive or negative, are likely to have serious implications for livelihoods in the country since such a shift in Climatological conditions is bound to lead to a shift in agro-ecological conditions, which in turn could have serious impacts on various economic sectors such as water, agriculture, land-use change and forestry, health, etc. It is therefore imperative for Lesotho to examine various technological possibilities that will form part of the country=s adaptation strategy to reduce its vulnerability to climate change.

The draft technology development policy

National policies on technology development in Lesotho have largely remained fragmented in terms of sectoral needs, with each participating government agency having its own isolated policy. This was due to the fact that until recently, there was no institutional focal point that could formulate a consolidated policy. It was not until 1994 that the Department of Science and Technology (DST) was established under the Ministry on Natural Resources, with one of the main responsibilities being to formulate and implement national policies and programmes that promote the development of science and technology, and to create an enabling environment in which technological development can make a meaningful contribution to national development.

The development of a policy on science and technology by the DST evolved through a process that began with a needs assessment workshop that was held in Maseru in February 2000.[5] This workshop recognised that despite problems of poverty and unemployment, Lesotho=s development continued to lag behind the country=s true potential. National planning and resource allocation tended to underestimate the critical role and potential impacts of science and technology. In addition, since low priority was given to science, technical education, science teaching in schools, and scientific research, Lesotho could not develop areas and products in which she had a competitive advantage. There was therefore a clear case for a cross-cutting policy on science and technology in the country.

According to Lesotho=s vision on science and technology, the country intends to build a free, prosperous and progressive economy and society both of which are sustained through the intelligent use of science and technology by intelligent citizens, corporations, and government.[6] There are five underlying principles to achieve this:

- Development of technologically competent and productive human resources;
- Creation and application of a mix of technologies that are appropriate to Lesotho=s market needs;
- Generation and marketing of high value-added goods, services and meaningful job opportunities for the country=s human resources;
- Exploitation of Lesotho=s resources and their comparative advantages in a sustainable manner, using information networks and alliances that are relevant to the country and the needs of its enterprises; and
- Enabling of indigenous businesses to grow and expand employment opportunities and export earnings.

[5]Department of Science and Technology, (2001) **Consultations for Science and Technology Policy Formulation in Lesotho**, Ministry of Natural Resources

[6]Government of the Kingdom of Lesotho (2003) **Lesotho: Science and Technology Policy 2003-2008** (Draft), p.23.

Some of the key elements of this science and technology vision include the need for technically competent and enterprising human resources; expanded science and technology education, vocational and entrepreneurial training and focussed research; competitive science and technology systems and fully developed information and communications technology, skills and infrastructure development, building efficient and effective national science and technology institutions and well-coordinated mechanisms; and upgrading of local value-adding capacities. In this respect, the government intends to harmonize sector policies and use science and technology to build an internationally competitive economy that is not only attractive to both domestic and international investors but incorporates traditional values and indigenous knowledge systems.

The core elements of Lesotho=s draft policy on science and technology are listed in official documents as follows:

- Build, maintain and actively promote a science and technology culture, infrastructure and links that are integrated with domestic production, markets, the education system and resource base;

- Facilitate access to up-to-date, reliable, cost-effective, well-coordinated and market-related science and technology information across various sectors of the economy;

- Exploit fully the country=s natural resources, human resources skills, talents and science and technology investments;

- Promote science and technology awareness and equitably distribute science and technology benefits, with special attention to women and rural communities; and

- Promote standards and mutual respect for intellectual property, including traditional technologies and indigenous knowledge systems.

The DST is not only the focal point for science and technology policy formulation but has a stakeholder coordination role. The framework for policy implementation points out that DST will be responsible for science and technology programme formulation, budgeting, technological studies and audits, the monitoring of impacts and compliance with national, regional and international protocols and environmental standards, including concerns about participation, gender and youth, culture and indigenous knowledge systems.

Despite the fact that the draft policy on science and technology was concluded in 2003, it has not yet received Cabinet approval. This drawback is exacerbated by the fact that DST remains a policy formulation and advocacy institution with very weak linkages with various operational science and technology institutions and stakeholders. In addition, the institution lacks a data bank that could provide a framework for either policy or programme formulation. The National University of Lesotho (NUL) has been commissioned to develop science and technology indicators and compile a national technology data bank.

In the meantime, the DST is compiling an inventory of practitioners in traditional medicine as a first step in a long-term objective to harness, produce and commercialize traditional medicinal plants and improve practices in this important area of indigenous knowledge systems. The institution also runs science and technology awareness campaigns through bi-annual exhibitions. DST has multilateral cooperation with institutions such as the Commonwealth Science Council. It is also in the process of forging a cooperation agreement with the RSA. However, what is clear at this stage is that the effective implementation of the new science and technology policy will require an overhaul of the current institutional setup, and an allocation to the same institutions of appropriate financial and human resources that have the necessary professional and technical expertise.

International and regional perspectives

According to the United Nations Framework Convention on Climate Change (UNFCCC), Parties to the agreement are expected to take precautionary measures to minimise the causes of climate change and

mitigate its adverse effects.[7] In view of this, the UNFCCC calls for the strengthening of systematic observation and national scientific and technical research capacities and capabilities; the training of scientific, technical and managerial personnel; the evolution of scientific and technological knowledge; and cooperation in scientific, technological, technical, socio-economic and other research that is undertaken as measures to facilitate adequate adaptation to climate change. This need to forge scientific and technological breakthroughs is more pronounced in countries that are very vulnerable to the adverse effects of climate change, Lesotho being a case in point.

Technological innovation and the diffusion and implementation of technologies and know-how for mitigation of greenhouse gas emissions deserve great urgency. According to article 4.5 of the UNFCCC, Athe developed country Parties included in the Annex II shall take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties particularly developing country Parties, to enable them to implement the provisions of the convention. In this process the developed country Parties shall support the development and enhancement of the endogenous capacities and technologies of developing country parties. Other Parties and organizations in a position to do so may also assist in facilitating the transfer of such technologies@. These clauses are testimony to the fact that the transfer of technology for adaptation to climate change is regarded at the international level as a crucial component of reducing vulnerability to climate change.

In line with provisions of the UNFCCC cited above, Lesotho has embarked on the identification, assessment and development of technologies that promote sustainable development without contributing significantly to greenhouse gas emissions. However, the country is aware that for both the developed and developing countries, including those in transition, there are barriers to the transfer of environmentally sound technologies (ESTs). Of the long list of these barriers that was presented by the Intergovernmental Panel on Climate Change (IPCC)[8] in 2000, the following were found to be very relevant to Lesotho:

- Inadequate resources for project implementation;
- Inadequate research and development resulting from low investments in research and development and poor science and educational infrastructure;
- Insufficient science, engineering and technical knowledge;
- Lack of data, information, knowledge and awareness, especially on Aemerging@ technologies;
- Insufficient human and institutional capabilities;
- High transaction costs;
- Inadequacy of policies or their absence thereof; and
- Excessive centralization of political and administrative authority.

Lesotho is not alone in facing the challenges that are posed by these barriers. The problem of lack of technological innovation and development is common throughout the whole of Africa. One of the institutions that have been assisting African countries in policy research in this area is the African Centre for Technology Studies (ACTS), a non-governmental organization that was established in Kenya in 1988 with the main aim to undertake policy research and training on the application of science and technology to sustainable development.

ACTS has instituted a series of African Technology Policy Studies (ATPS) with the aim to improve individual and institutional capacity for technology policy formulation, implementation, research, analysis,

[7]Climate Change Secretariat (May 1992) **United Nations Framework Convention on Climate Change**, Article 3 (3).

[8]IPCC. (2000). **Methodological and Technical Issues in Technology Transfer,** Cambridge University Press.

assessment, monitoring, evaluation and dialogue. Lesotho has recently added its own chapter of the ATPS known as the Lesotho Technology Policy Studies (LTPS), with its focal institution as the National University of Lesotho. LTPS has become one of various initiatives that aim at strengthening the framework for technological development in the country. Technology development has also become a thematic issue at regional bodies such as the Southern African Development Community (SADC). Not only is there concern about the advancement of science and technology but about biotechnology and its safe application (bio-safety). The latter issue has become urgent due to the current food crisis that is facing SADC regional states as a result of the protracted drought of recent years.

While there is a general recognition that biotechnology carries a good potential to increase agricultural yields, the potential for environmental effects remains a big challenge, requiring SADC countries to protect their rich plant and animal genetic resources from undesirable crossing with genetically modified varieties. It is imperative that the region embarks on capacity development with the objective to deliver regulatory and testing services to manage the introduction, production, and use of genetically modified organisms (GMOs).

2. NATIONAL EXPERIENCES

Introduction

National experiences with technology development in Lesotho have mainly been limited to agricultural research, research on labour-intensive construction, and research on technologies that are deemed appropriate for rural development. In addition to various rural development efforts, a number of government agencies have also been actively involved in the execution of technology development programmes, each with a specific mandate and organizational approach. Notable here are the development of low-cost sanitation systems, low-cost housing developments, soil conservation and reforestation efforts, and clean technology dissemination for refrigeration.

A number of initiatives have also been undertaken by the private sector in the areas of sandstone quarrying, waste recycling, and information technology; by civic organizations such as the Machobane Agricultural Development Foundation (MADF), and by independent projects. However, most of the major initiatives that were introduced in the early 1970's and early 1980's were donor-driven, and their sustenance has been directly dependent on the continued flow of donor funds. On the other hand, despite the renewed interest in science and technology today, there is as yet no indication that there will be dramatic institutional modifications and significant changes in the allocation of public resources in the near future.

Agricultural research

The oldest attempts at technological development in Lesotho centred around investigative work on fertilizers and seed varieties in support of the dry land farming of traditional crops such as maize, sorghum, wheat, beans and peas. The Agricultural Research Station, a section of the Crops Division of the then Ministry of Agriculture was set up in Maseru in 1952 for this purpose. The mandate of this institution expanded gradually until the establishment of the Agricultural Research Division (ARD) in 1978. From this period up to the mid-1980s, massive donor-assisted efforts shifted attention to research that aimed at the diversification of the agricultural base in order to build food self-sufficiency,[9] maintain and improve the agricultural resource base, generate employment and incomes, produce raw materials for local processing, and generate foreign exchange.

Agricultural research now focuses on the investigation of various kinds of crops against technical constraints such as temperatures, rainfall, frost, hailstorms and marketability. Emphasis is placed on labour-intensive, high-value and drought resistant crops. Profiles for the growing of many crops, including farm budgets, have been developed although the demarcation of geographically suitable areas has not taken-off due to low institutional capacity and inadequate institutional linkages. There has also been independent, albeit uncoordinated, research that has been carried out by various projects involving irrigation systems, various extension techniques, and reforestation.

In recent years, research has centred on the collection and conservation of germ-plasma, soil improvement through liming, range recovery, seed multiplication, the development of appropriate mechanisation systems, and development of simple irrigation techniques and appropriate post-harvest techniques. Adaptive research has necessitated the opening up of twinning arrangements with research institutions in the neighbouring Republic of South Africa (RSA) and in other countries in the sub-region. Unfortunately, there have not been any attempts to institute quantitative surveys to assess the adoption of agricultural technology in recent years. Such analyses would lead to the improvement of the efficiency of the new technologies, improvements in the effectiveness of technology transfer, to understanding the role of policy in the adoption of new technologies, and to a demonstration of the impact of investing in technology development.[10]

[9]This policy was abandoned in the early 1990s in favour of household food security.

[10]CIMMYT Economics Programme, (1993), **The Adoption of Agricultural Technology: A Guide for Survey Design**, Mexico, p.7

Besides institutional problems that include inadequate research capacity and severe budgetary constraints, the dissemination of new agricultural technologies to farmers has generally suffered from weak institutional linkages, particularly research-extension linkages[11], as well as from financial limitations on the part of farmers. Other pervasive constraints include inefficient marketing systems, lack of credit facilities, poor distribution networks, low investments in production, and low educational levels on the part of intended beneficiaries.

Appropriate technology research

The need for the design, practical testing, and dissemination of effective and/or new techniques or equipment that was appropriate to the needs and resources of rural people was strongly felt in the 1970s in line with international concerns with rural development. Technological innovations were required to support:

- rural productive activities including food processing and preservation;
- income-generating activities such as spinning and weaving;
- production of building materials, and
- energy production and conservation.

The objective was to develop socially and culturally acceptable technologies that would deliver immediate benefits to rural communities.

Appropriate technology units were established as pilot initiatives in various parts of the country and by several government agents and donor funded projects. Their activities centred around the development of solar energy, the design of rural structures, food preservation involving improved grain storage and methods of solar drying of vegetables, and affordable spinning and weaving techniques. Perhaps the most notable undertaking was the renewable energy technologies project that aimed at developing technologies that were not only economically viable but directly met the needs of rural households.

Activities under the renewable energy technologies project included the design of wood and dung-burning stoves, the design of thatch insulation for houses with corrugated iron roofs, the application of pedal power for grinding grain, the design of grow-hole greenhouses and community passive solar houses, and practical research on biogas. Concern with the development of appropriate technology led to the establishment in 1979 of the Appropriate Technology Section (ATS) of the then Ministry of Rural Development, an institution that was mandated to undertake appropriate technology research, the development and application of these technologies, and the dissemination of economically viable results thereof. This institution was re-enforced by the Renewable Energy Technologies Project in the early-1980s.

From mid-1980s to mid-1990s, ATS remained a marginal institution that lacked all the essential requirements to fulfil an engineering research and design function. It was not until 1997 that 5 engineering positions were approved for the institution. Today the ATS professional research staff complement stands at 8 engineers, with 2 vacant positions. Despite this improvement, Lesotho still lags far behind other regional member states in professional human resource allocation to technology development. The institution also runs on a low annual budget of M3 million. To make matters worse, ATS achievements and all the prototypes were completely destroyed during political riots of 1998, forcing the institution to start afresh.

Today the ATS runs 6 core programmes: food technology, renewable and biogas technology, small-scale agricultural implements and technology, entrepreneurship and production, public understanding and human resources development. Pipeline projects have been conceived in the areas of spinning and

[11]Phororo, D. R. and Ntsane C., (June 2001) **Agricultural Research Impact Assessment Survey on Research Technologies/Innovations**, Ministry of Agriculture, Cooperatives and Land Reclamation, p.21

weaving, construction and building, and ecological sanitation (recycling). ATS collaborates with the Central University of Technology (former Free State Technikon) for the development of stone quarrying and milk and meat preservation technologies, and with the Cape Technikon for the development of solar energy. Other projects in the pipeline include the development of technologies for mushroom production and for candle production from bee hives, and the development of a cabbage planter, a chicken plucking machine, a wheat thresher, and a sulphur drier.

Other objectives of ATS include the adaptation of technologies in order to make them suitable for local needs and conditions, carrying out market-driven research, dissemination of new technologies and research results nationally and internationally, and ensuring that recommended technologies are environmentally friendly. So far mature technologies that have been developed by ATS include: food driers (meat, vegetables; etc.); stoves (*mabotle*, *nkokonono* - institutional and domestic, and TTI); the manually operated water pump; the commercial bread oven; the metal plough beam; the metal work; the briquette press for recycling paper - commercial and domestic; the glass cutter for recycling glass into wine glasses and candle sticks. The institution runs 3 workshops: at Malefiloane in the mountain district of Mokhotlong, at Khubetsoana in Maseru, and at Ha Sekake in the Qacha=s Nek District.

With over 22 projects running, ATS is clearly overstretched. Collaboration with other national institutions has remained weak and piecemeal. There are also weak linkages with major stakeholders such as the Departments of Energy, Meteorology and Science and Technology, and Ministries such as Environment and Agriculture. This tends to limit the impacts that ATS technology can have nationwide. Other limitations include low investment in technological development by local industry, a situation which compels ATS to lean more towards community as against commercial technological needs.

Labour-intensive construction

After the massive retrenchment of Basotho who were employed in the mines of the RSA in early 1974, the World Bank initiated research projects in Lesotho that Ademonstrated that properly organised and supervised labour-intensive construction could be efficient and not much more expensive than capital-intensive works@.[12] This led to the adoption of the policy of labour-intensive public works construction and the establishment of the Labour Construction Unit (LCU) in the Ministry of Works with the explicit objective to expand wage employment and lay down a framework for both short- and long-term rural development.

Despite emphasis on the application of labour-intensive technologies in all the sectors of the economy throughout the 1980s and 1990s, such techniques remained confined to programmes of the LCU and the Civil Works Section (CWS) of the Ministry of Local Government. These two institutions have now merged into the Department of Rural Roads (DRR) under the Ministry of Public Works and Transport. This institution is responsible for the maintenance of 1853 kilometres of gravel roads and 926 kilometres of earth roads throughout Lesotho=s 10 districts. It is currently upgrading 448 kilometres of gravel and 103 kilometres of earth roads. There is also an additional 518 kilometres that has been allocated to the DRR but is not yet attended to. This gives a total 3,848 kilometres of network on which the DRR is supposed to apply labour-based technologies.

On DRR roads, labour-intensive methods of construction are applied on tasks such as formation earthworks, quarrying, loading, and gravel spreading. In the same breath, the excavation of drains, construction of drainage structures, and mixing of concrete and mortar are done manually. The work is normally of one month duration to enable broad participation and the distribution of employment benefits, making this institution one of the critical ones in poverty intervention. Although there remains a lot of scope for the application of labour-intensive methods of construction in various sectors of the economy, such techniques have been confined to agricultural infrastructure works involving soil conservation structures; to the construction, upgrading, and maintenance of access roads and footbridges; and to environmental protection and rehabilitation.

[12] JASPA, (1979) **Options for a Dependent Economy: Development, Employment and Equity Problems in Lesotho**, p.153.

Rural water supplies

Like many rural development initiatives in Lesotho, the development of clean water supplies to rural communities began in the late 1970s and picked up momentum during the International Drinking Water and Sanitation Decade (1980-1990). The programme, spearheaded by the Department of Rural Water Supplies (DRWS), was closely integrated with sanitation and health education, all of which attracted substantial donor funding, leading to a sharp increase in coverage from 15% of the population in 1984 to 56% in the mid-1990s.The objective was to supply 30 litres of clean water per capita per day within a distance of 150 metres. This important programme has suffered setbacks with the phasing out of donor support. Coverage figures are said to have gone down due to system failures that resulted from poor maintenance and management problems.

Most of the rural water supplies are extracted from ground water sources and the choice of technology is given serious consideration. Gravity-fed systems are preferred where they are technically and economically feasible since they are found to be more reliable and involve lower maintenance costs than hand and electric/diesel pumps. For reticulation, the preferred choice is the provision of a communal standpipe or hand-pump for every 100 persons in a village. When funds are a constraint, rural communities are provided with a source protection as an interim measure.

Despite being an important programme in poverty alleviation, the rural water supplies programme, has not attracted a lot of funding from local sources, with the result that rural communities have suffered in recent years as drought conditions become more frequent and donor support more difficult to come by.

The rural sanitation programme

In 1994, official figures showed that only 20% of the population in Lesotho had access to adequate sanitation facilities.[13] The coverage with sanitation was lowest in the mountain districts where less than 10% of the population in these districts had adequate sanitation. The ventilated improved pit latrine (VIP) is by far the most popular sanitation technology in the country. In fact on-site sanitation systems will remain the most cost-effective technological solution to environmental protection in the foreseeable future. Sewer toilet facilities are confined to urban areas where less than 5% of the population have access to these, and to isolated settlements such as mission schools.

Pit latrines do not cause serious environmental problems in Lesotho since ground water tables are generally ∀30 metres deep. However, a study[14] in 1995 found that only 25% met the VIP standard that requires pit latrines to have a fly screen, concrete slab, and intact door. Associated with this is the fact that in peri-urban areas, inadequate designs of conservancy tanks and their poor maintenance and infrequent emptying pose serious threats to the environment and health. Blockages, overflows, leakages and offensive odours have become very frequent in recent years as the urban population grows faster than facilities provision.

Various attempts have been made to improve the sanitation situation in Lesotho. One of such attempts was the African Development Bank (ADB) supported Rural Sanitation Project under the Ministry of Health. This project supplied latrine component parts (iron rods and vent pipes) at a subsidized price of M50, and provided village communities with sanitation education. It also trained local latrine builders who in turn offered their services to the community at a cost of M250 for a single and M350 for a double VIP latrine construction. Despite the subsidization, many poor households still found the VIP latrine not affordable. Today the coverage ranges from as high as 80% in some lowland districts to as low as 20% in mountain districts.

[13]Ministry of Economic Planning (November 1995) **Water Supply and Sanitation Action Plan**, Volume I

[14]TAMS Consultants (September 1996) **Water Resources Management: Policy and Strategies**, Final Report, Annex N.

Low-cost housing development

Attempts at introducing technology development in the housing sector in Lesotho date back to the late 1970s and early 1980s when the government-backed Lesotho Housing Cooperative (LEHCoop) introduced a programme to construct low-income housing. This involved the provision of serviced sites for self-help housing construction in urban areas where the land laws allowed such developments. Using small loans for building materials, low-cost housing units were built using self-help labour on a cooperative basis. Some of the materials such as bricks were produced on-site. LEHCoop was responsible for infrastructure development (roads and the sanitation core). Unfortunately, donor funding for this initiative dried up, leading to a collapse of the cooperative in the mid-1980s.

The functions of LEHCoop were absorbed by the Lesotho Housing and Land Development Corporation (LHLDC), a parastal whose mandate is the provision of affordable housing and with property development, and by the Maseru City Council (MCC). Unfortunately, the low-cost technology seems to have been dropped in favour of selling serviced sites, most of which are out of reach to the average household. As a result, vast expanses of informal settlements are a common feature in all urban settlements in Lesotho, with buildings built mainly of imported materials whose suitability for Lesotho is sometimes questionable. Current policies[15] have shifted emphasis to the development of regulatory instruments, to environmental and financing issues, and to the development of the road infrastructure within settlements. It is hoped that more will be done for the development of low-cost housing after the operationalization of local government in the country.

Other initiatives

A number of technology development initiatives have been pursued in almost every economic sector in recent years. In the agricultural sector, a number of experiments have been carried out to determine the most suitable extension model, the most suitable irrigation systems, and the most productive farming systems. The Machobane Agricultural Development Foundation (MADF) has been promoting the Machobane farming system (MFS), a method of farming where several crops are inter-cropped in order to ensure multiple harvests all year round by exploiting differential crop maturities. This labour-intensive farming system utilises local resources such as kraal manure and ash in the production of crops such as wheat, sorghum, beans, peas, potatoes, maize, vegetables, etc. on a rotational basis for continuous harvesting throughout the year.

In recent years, there has been a mushrooming of sandstone quarrying activities that include stone shaping. There have also been attempts at the preservation and adaptation of old stone buildings to suit modern needs. Sandstone, an abundant local resource, is now regularly used in the construction of public buildings and shopping centres. Employment levels in this labour-intensive industrial activity has increased rapidly in recent years. The leading private company, the Lesotho Sandstone Company, has its operations in Maseru from where stone is exported to various cities in the RSA.

Although Lesotho generates over 800,000 tons of dry waste per annum,[16] only 1% is recovered for recycling. The waste generation capacity has substantially increased in recent years in the face of inadequate collection and poor regulation, a situation that poses serious threats to health and the environment. Very limited recycling technology has so far been developed, the most notable being the briquette press that was developed by ATS for recycling waste paper into fuel energy for cooking and heating.

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[15]Department of Housing (July 1999) **National Shelter Policy for the Kingdom of Lesotho**, Ministry of Local government

[16]Mhlanga, M. and Gulilat, T (1997) **Waste Management in Lesotho: A Baseline Study**, National Environment Secretariat.

In addition to growing interest in science and technology at the policy levels in Lesotho, there has been a rapid expansion of private sector driven information technology, leading the country to create a Ministry of Communications, Science and Technology in 2003. Even if there is very little adaptation taking place, the connectivity and data handling capacities of many institutions have substantially improved. Activities so far involve satellite and computer and internet installations, maintenance of computer systems, expansion of cellular-phone and landline coverage, and liberalization of air waves. Leading IT companies such as Quadrant Computers, Computer Business Solutions, and Comnet run regular IT courses and carry out maintenance activities. Electronics companies have also emerged although activities are limited to assembling for export.

The communications industry has also seen attempts at stabilizing service delivery by substituting copper telephone lines with the fibre optic cable. This initiative is piloted in Lesotho by Telecom Lesotho with capitalisation by Eskom, an RSA utility company that has acquired shareholding in the Lesotho utility through a privatization scheme. Not only does the fibre optic cable withstand disruption of service that results from wire theft, but offers higher and diversified capacity, as well as opportunities for easier maintenance. This new technology has proven to be quite suitable for rural areas where vandalism was very widespread and where a number of off-farm jobs have been created. More than 500 kilometres of cable has been installed from Maseru to Quthing, around Maseru, and from Maseru to Roma. A further M154million investment is currently in the pipeline for further expansion.

Technology registration

In the past, Lesotho depended on the RSA for the registration of intellectual property, technologies, trademarks and patents. In 1989, the country passed two pieces of legislation, the Copyright Order (Number 13) of 1989 and the Industrial Property Order (Number 5) of 1989, in order to facilitate the local registration of inventions and literal works. Prospective clients apply for registration through the Department of Property Rights in the Ministry of Law and Constitutional Affairs. This Department also runs an outreach programme through radio, and go out to schools and colleges to educate people about the importance of protecting their inventions and literal works.

Lesotho is a member of the World Intellectual Property Organization (WIPO), and of the African Regional Intellectual Property Organization (ARIPO) which is based in Harare. These two organizations offer technical assistance and cooperation activities in the areas of the protection of intellectual property rights. In fact technical applications for the registration of copyrights in Lesotho are currently submitted to ARIPO for substantive assessments upon payment of a fee since there is no capacity for such assessments amongst local institutions. On the other hand, enforcement of intellectual property rights and copyrights is still at its infancy. Current efforts are limited to creating awareness amongst customs officials and the police.

Technology transfer mechanisms

Shows, fairs and exhibitions

The Ministry of Agriculture and Food Security organizes annual district and national shows where farmers and industrialists display their products for the public to view. A number of technology development institutions also display their devices. However, lack of infrastructure at the site of agricultural show grounds remains a serious constraint. The Lesotho Manufacturers Association (LMA) also holds bi-annual exhibition shows in Maseru for the same purpose. Similarly, the Lesotho Mathematics and Science Teachers= Association organizes annual maths and science fairs for both primary and secondary school pupils. Students present projects that carry their scientific and technological imaginations in solving real world problems.

Extension services

Tested and approved technologies that are developed by the ARD are supposed to be disseminated to farmers by the Department of Field Services in the Ministry of Agriculture and Food Security through its countrywide network of District Agricultural Offices, agricultural resource centres, and field extension officers. Other technology development centres such as the ATS do their own extension work, having

contacts with rural communities through regional offices and through shows, fairs and exhibitions as has been reiterated above. In general, extension services remain weak and uncoordinated, while extension agents remain weakly connected to technology development centres.

Radio and other services

Radio, web technology, posters, billboards and pamphlets and print media are often used to disseminate new technology messages. Unfortunately, coverage in the remote areas, particularly in the mountain region, remains poor, while illiteracy and poor infrastructure remain major obstacles in the case of written messages.

3. TECHNOLOGY, EDUCATION AND TRAINING

Introduction

Technology is generally defined as a design for instrumental action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome. It comprises both the hardware and software whereby the hardware consists of the tool that embodies the technology as material or physical objects, while the software consists of knowledge and skills, procedures and/or principles in that area of information base for the tool. Indigenous knowledge systems, as related to the entire culture of a people, including its identity and spiritual and religious beliefs, are part of their technological endowment and form part of their development. The significance of the traditional knowledge systems must therefore be respected for their cultural values, and as such, the rights of people to maintain these values must be acknowledged and protected in the development process.

Studies have shown that there is no contradiction between the maintenance of strong cultural traditions and identities on the one hand, and economic development on the other. In fact, there is a strong argument that for development to be socially and environmentally sustainable, it must take into consideration and draw upon the values, traditions, and cultures of the people in the countries and societies that it serves.[17] Unfortunately, Lesotho, like many countries that have recently emerged from colonial oppression, lost a substantial part of her cultural traditions and values. The loss of land from territorial wars with Boers in the early 19th century and the resultant land degradation, the outlawing of many traditional practices, including medical practice, and the forced adoption of foreign cultural values and traditions, led to a severe erosion of indigenous and traditional knowledge systems in the country.

Traditional knowledge systems are developed from generations of scientific experience with natural resources and the environment. A disruption of this trend has compelled many vulnerable countries such as Lesotho to depend heavily on imported technologies, many of which are not well adapted to local conditions. Following a widespread recognition of the value of indigenous knowledge systems and growing interest in the same by the international community, and attempts to seek mutual support and common ground between modern and traditional technologies and value systems, Lesotho intends to embark on a revitalisation of her cultural and indigenous knowledge systems and harness these for development in various areas of development including biodiversity, medicinal plants, land use and the environment, community development, etc.

The scientific principles of indigenous knowledge systems are passed on through folklore, rituals, ceremonies, proverbs and other forms of apprenticeship. Since the weakening of the components of this system, Lesotho has not been able to develop an integrated system of technological development, leading the country to be turned into a consumer of imported, un-adapted and largely inappropriate technologies rather than a generator of Alocally-brewed@, appropriate technologies. On the other hand, while a lot of emphasis has been placed on the teaching of mathematics, science and technical studies in all of Lesotho=s development plans, up until now institutional training has largely remained academic and generic as against adaptive and inventive.

Current education and training policies

Bearing in mind the pivotal role education and training play in enriching the life, skills and well-being of the population, Lesotho has, since independence, put a very high priority in the development of human resources, with education receiving the highest allocation of the country=s development resources. Education and training have been seen as agents of social and economic development. However, the content of the education system has been described in official documents as marginally relevant to the development needs of the country, and the teaching of science and mathematics, both of which are critical to technology development, has been described as very weak.

[17] See Davis, S.H. & Ebbe, K. (Eds) (1993) **Proceedings of a Conference on Traditional Knowledge and Sustainable Development**, World Bank, Washington D.C. 27 B 28 September.

Since education was marginally related to the development of skills and aptitudes that were required to achieve rapid economic transformation and improve the standard of living of rural communities,[18] the transformation of the same in terms of relevance, quality, and access has been the central theme of all of the education sector development efforts in Lesotho. While still pursuing these objectives, current efforts in the Ministry of Education put a lot of emphasis on issues of equitable distribution of resources, participatory management and governance as well as integration with the local economy. In future, more emphasis will be placed on the integration of vocational education with industrial development as well as with skills needs of various sectors in the economy. The Ministry of Economic Planning is in the process of developing a new human resources development policy that will underline some of these principles.

As of 1 August, 2004, the National Manpower Development Secretariat (NMDS), a body that is responsible for the administration of the government=s scholarship programme, published its priority areas for funding as follows: (a) information and communications technology and related courses; (b) maths, science and related courses; (c) tourism sector and related courses; (d) economics, business and related courses; (e) maths and science education and related courses; (f) agriculture, environmental science and related courses; (g) health sciences and related courses; (h) engineering sector and related courses; (i) build and technology sector related courses; and (j) design and technology sector related courses.

The bias towards science and technology is therefore quite apparent in the current funding priority list. The ultimate objective is to produce a pool of human resources with appropriate occupational, technical and managerial skills that will open up avenues for self-employment and other income generation, hence the need to create and expand apprenticeship skills at technical and vocational schools, and the need to streamline syllabi by putting emphasis on those skills that are necessary for the country=s socio-economic development.

In all official documents on education and training, the government has committed itself to the promotion of activities relating to science and technology in the school curricula, and high priority is given to the teaching of mathematics and science at all levels of the education system. In order to encourage and prepare youth to choose careers in the scientific fields, technical and vocational education has also been given high priority while extensive efforts are made to apply appropriate technology in rural production with the aim of increasing productivity. These policy objectives have necessitated the application of substantial resources to the development of appropriate curricula.

Curriculum development

The need to reorient school curricula in Lesotho was felt immediately after independence from British rule in 1966. The first national development plan underlined the need to (a) lessen the bias towards academic objectives, (b) put more emphasis on science and mathematics, and (c) shift to training that was geared towards meeting the country=s development needs. This led to the establishment of a Primary Curriculum Development Unit in the Ministry of Education in the mid-1970s, an institution that evolved into the National Curriculum Development Centre (NCDC) in 1980. The main objective at this stage was to undertake a thorough analysis of course content and instructional materials and methods, and to link programmes more closely with employment opportunities that existed in the country.

Efforts at revising school curricula at all levels of the education system have been going on for some time, with a lot of emphasis on primary education. A lot of funds have also been spent on the development of science in the country with the aim that it should meet developing needs of the country. However, the implementation of new curricula is generally hampered by inadequate support infrastructure, the shortage of science and technical teachers, inadequate equipment and teaching aids, weak management at the school level, and the need to retrain teachers in new approaches.

In addition to the revision of curricula, an attempt to introduce and promote the practical applications of science into learning in primary schools came with the distribution of science kits which began in the

[18]Central Planning and Development Office (December 1970) **Lesotho: First Five year Development Plan 1970/71-1974/75**, p.163.

1970s. Initially, each district was supplied with a single box containing equipment aids. However, it is believed that at the moment 20% of the primary schools in the country have received these kits in recent years, with World Bank assistance. The aim is to cover all the primary schools in the country. In addition, primary curriculum resource teachers that organize workshops for other teachers on new curricula, as well as district resource teachers have been trained in the use of these science kits for dissemination.

One of the earliest efforts at promoting the teaching of science at schools in Lesotho involved the establishment of a Production Unit whose task was to produce local low-cost teaching aids for both primary and secondary schools. Although the institution still exists, distributing its products through the School Supplies Unit, the demand for these products remains very low as most of the schools prefer more expensive higher quality imported products.

The NCDC continues its work on the design of syllabi for both primary and secondary schools. The aim is to make these syllabi more relevant by incorporating more practical and imaginative day-to-day applications using locally available materials. In-service training courses are also regularly organized for teachers, using new syllabi and teaching methods. At secondary school level, schools are encouraged to assist students to embark on science projects where they attempt to design things that add value to their lives although the latter do not enter the grading system. Locally-produced science textbooks and various teaching materials, including a science kit manual for primary schools, are now in use throughout the country.

In order to achieve its set objectives, the NCDC has divided its work into 14 different specialties. Its work is also supported by an evaluation, testing and research division, and by instructional design and materials editing functions. These programmes are supported by 3 major projects as follows:

- A Danish financed Lesotho Environmental Education Support Project (LEESP) - This 3-year project was initiated by the National Environmental Secretariat (NES) in pursuit of Agenda 21[19] after a realization that the Environment Act (Number 15) of 2001 was silent on the integration of environmental education with formal school syllabi. This project has produced an environmental education Areference note@ that has become the official policy on environmental education;

- A United Nations Fund for Population (UNFP) financed Population and Life Skills Project whose objective is to integrate AIDS and hygiene education into all subjects in schools; and

- A World Bank financed Curriculum and Assessment Project that aims at reviewing the curriculum policy and at streamlining curricula and integrating major issues that emerge from donor-driven initiatives.

Attempts are underway to introduce business education and information technology in schools. The objective of this programme is to prepare young people to adapt to economic and technological changes, inculcate business both as a skill and as a culture, and use information technology as a tool to solve problems and not for its own sake as is presently the case. Final tests of this syllabus are underway at 13 schools. In general, the introduction of information technology in rural schools is facing a number of constraints that include the following: (a) the absence of a comprehensive policy framework, (b) lack of orientation towards information technology amongst teachers, (c) the absence of cheaper and relevant software packages, (d) failure of many schools to afford connectivity, (e) lack of support infrastructure such as electricity and telephones at most of the schools, and (f) lack of appreciation of the importance and benefits of information technology by management at many schools.

In order to support the transformation of education in the country, a lot of efforts have been made to improve school infrastructure in recent years through Phase II of the World Bank/ADB financed Education Sector Development Project (ESDP II). These efforts include the construction of new schools in under-served areas, support for programmes to improve the administration and management of schools, supply of teaching aids, and improvement of access by supporting the introduction of free primary education.

[19]United Nations (1992) **Agenda 21: The United Nations Programme of Action from Rio**, New York

The overall aim of curriculum development remains the generation of appropriate occupational, technical, and managerial skills that will enable meaningful participation in the country=s socio-economic development.

School programmes

Training in the fundamentals of mathematics and science has always been a crucial component of education since late 1970s when the NCDC initiated the development of primary school syllabi with an objective of strengthening the mathematics and science components, an objective that was also underlined in the Education Sector Development Plan 1991/92-1995/96 and subsequent official documents. This led to the revision of curricula so that they could lay more emphasis on productive activities and encourage practical orientation in the teaching of core subjects.

In 2002 there were 1,333 registered primary schools throughout Lesotho, up from 1,264 schools in 1998. Many of these schools are characterised by scanty facilities, inadequate classroom space, large pupil/teacher ratios, and poor access by supervision staff. Although the ADB has assisted the construction of over 100 primary schools since 2000, particularly in under-served areas, these challenges will continue to constrain education development efforts at this level for some time. To facilitate the achievement of sector objectives, the government has also embarked on a free primary education programme, wired all the new schools to enable them to use various forms of power supply as and when it becomes feasible, begun initial attempts to decentralize the education system, and introduced the tripartite school management and administration model that involves parents, teachers and the government in line with the Education Act (No. 10) of 1995.

The number of secondary and high schools also increased from 205 in 1998 to 224 in 2002. Their constraints are generally similar to those of primary schools. Lack of laboratories, workshops, equipment and teaching aids puts severe limitations to the teaching of science and technical subjects at these schools. The situation is exacerbated by the shortage of science and technical teachers, and by lack of electricity, particularly at rural schools. Of the 31 subjects that were offered at the junior certificate level of education in 2002, only 11 could be regarded to be in the domain of mathematics, science and technology. The number of subjects that could be classified to be in the mathematics, science and technology domain was slightly higher at the high school level. Out of a total of 34 subjects offered in 2002, 16 could be so classified. On the other hand, table 1 shows that science teachers at secondary schools constitute a mere 26% of the total number of teachers.

Table 1 Secondary School Teachers by Qualification, 2002

Qualification	Science	Non-Science	Total
Degree or higher	540	1288	1828
STC or Equivalent	266	705	971
PH and COSC	42	156	198
Unqualified	17	370	387
All Teachers	865	2519	3384

Source: Planning Unit, (2002) **Education Statistics 2002**, Ministry of Education and Training, table 50.

To facilitate the teaching of science and technical subjects at secondary and high schools, 20 laboratories and 14 workshops have been constructed and fully equipped at various schools since 2000, with ADB assistance. These were supplied with 3-phase electricity either from the Lesotho Electricity Corporation (LEC) grid or from generators. However, the limitations to the teaching of science and technical subjects remain massive. This is reflected not only in the limited number of science and technical subjects that are offered in secondary and high schools, but in poor pupil performance in examinations.

In 1980, the Mathematics and Science Centre that had been established in 1971 as an in-service training institution for teachers and laboratory technicians introduced a course for students that had not qualified for direct entry into university. In the mid-1980s this programme was converted into a pre-entry course for those who intended to pursue science degrees or wanted to pursue technical/vocational courses that had a science leaning - the Lesotho Science Pre-entry Course (LESPEC). This 6 months bridging course concentrated on mathematics, science, and English. Upon phasing out of EU funding in 1992, the National University of Lesotho (NUL) introduced its own pre-entry science programme (PESP) of 3 months duration. On the other hand, the Lerotholi Polytechnic introduced an intensive programme of mathematics and science for diploma students.

Technical and vocational training

In 2002, there were 1859 students that were enrolled for technical and vocational courses at 8 institutions in Lesotho. This was 40% less than enrolment in 2001. The minimum entry points for these courses differed, ranging from the primary school leaving certificate (PSLC) (23% of total enrolment), through junior certificate (JC) (38% of total enrolment), to Cambridge Overseas School Certificate (COSC) (39% of total enrolment). The biggest enrolment was at the Lerotholi Polytechnic which claimed 37% of total enrolment. This institution carried 90% of the 20 courses that were offered in this year. The Leloaneng Trades School and the Technical School of Leribe also fared better, each carrying 5 courses. The rest of the technical and vocational schools are owned by churches and merely offered home economics, business and secretarial studies. Bishop Allard, however, also offered bricklaying and carpentry and joinery.

The Lerotholi Polytechnic was established in 1992 as a merger of the Lerotholi Technical Institute, a craft/trades training school that was founded in 1905, with the Technical Training School of the Ministry of Works and the Commercial Training Institute. The present institution runs 3 major departments: (a) the school of the built environment which offers a certificate course in bricklaying and plastering, a certificate course in carpentry and joinery, a diploma course in construction engineering and architecture, and a diploma course in civil engineering; (b) the school of technology with diploma courses in mechanical engineering and electrical and electronics engineering; and (c) the school of commerce and applied studies with diploma courses in secretarial studies, business studies and marketing and salesmanship.

Since establishment, the Lerotholi Polytechnic has shifted its image away from an institution that was generally regarded as a dumping ground for those who could not qualify for further education, to a competitive institution with high entry points for all courses. Enrolment has increased sharply from around 80 in the early 1990s to around 700 in 2004. The institution seeks to strike a balance between building entrepreneurial skills where those who complete courses can establish their own businesses, and the need to prepare students for institutions of higher learning abroad. It is planned that the Lerotholi Polytechnic will gradually evolve into a fully fledge university of technology. At the moment, the institution is planning to introduce courses in pattern design and dressmaking, in line with the central role played by the textile industry in the economy today.

There is a general complaint that those who enrol for technical and vocational courses are individuals who obtain the lowest grades in the entry examinations, implying that technical and vocational courses are chosen as a last resort, hence the general poor performance. In recent years, however, those with good qualifying grades, as well as graduates of technical and vocational institutions in Lesotho opt for higher level courses at RSA institutions that offer higher standard and more practically-oriented courses.

Despite the fact that technical education started as early as colonial times in Lesotho, the Technical and Vocational Education Department (TVED) was only established in 1987 after the Lesotho Technical and Vocational Training Act (Number 25) of 1984 came into operation[20]. The major objectives of this institution are listed as:

- To facilitate the development of productive human resources with skills and aptitudes to promote a dynamic and sustainable economy; and

[20]Through Legal Notice No 60 of 1987

- to mobilize and encourage entrepreneurial skills, and integrate them with technical and vocational education and other training programmes.

In addition to inspection, TVED gives advisory support to 80 out of 210 secondary schools in the area of basic hand-crafts - woodwork, metalwork, and technical drawing. It also works with 8 institutions that give post-secondary technical and vocational education. The provision of hospitality courses is currently under consideration. The day-to-day functions of TVED include the accreditation of technical and vocational education training instructions of various institutions, the development and administration of the national crafts curricula, national diploma assessments, liaison and collaboration with industry, development and administration of trade tests, and setting of training standards of technical and vocational education.

The law guiding technical and vocational education is currently under revision with the aim to provide apprenticeship training and improve the practical orientation of training. There is also very close liaison with industry to facilitate student attachments and assessments thereof. Representatives of industry sit not only on the TVED Board, but also on the Curriculum Development Committee that was established in 1998 for 6 different training fields. Unfortunately, there is currently no private sector financial support for TVED objectives and relations with the industrial sector remain weak, with many establishments preferring to conduct their own training.

The last tracer studies for graduates of technical and vocational schools were undertaken in 1997. TVED has therefore not been able to closely assess the employment impacts of technical and vocational training in Lesotho. At the moment, it is difficult for graduates of technical and vocational schools to get jobs in the country, with many settling for piece jobs. One of the problems has been identified as the failure to closely match training with the practical needs of the country. The other relates to relatively low remuneration and poor working conditions in Lesotho. It is hoped that the new technical and vocational education policy will address some of these short-comings.

University and other tertiary training

There is only one university in Lesotho, the National University of Lesotho (NUL), an institution that was established in 1945. Since establishment, NUL has concentrated on the teaching of humanities and natural and social sciences. Limited opportunities for further development at home, particularly in technical fields, has compelled many students to seek such opportunities abroad, usually with extensive government support. Attempts are now underway to broaden the science base of university education within the country.

In 2000, the Faculty of Science at NUL was renamed the Faculty of Science and Technology and a new programme, the Bachelor of Technology degree in Information Technology and Information Technology and Electronics, was introduced. This faculty also offers a degree course in health sciences. In addition, the Faculty of Agriculture, also a relatively new venture, merged with the Lesotho Agricultural College to offer a number of specializations in many agricultural fields. However, inadequate infrastructure and limited budgetary support remain pervasive constraints.

In 2002, 3,145 Basotho students were registered at NUL, 288 of them in certificate and diploma courses, 2,787 in undergraduate courses, and 70 in graduate courses. A breakdown by course showed that those who were doing science and related courses (mathematics, natural sciences, agriculture and health sciences) constituted 72% in certificate courses, 21% in undergraduate courses, and a mere 13% in graduate courses. There were relatively more male students who were registered for undergraduate courses in sciences than female ones, 28% as compared to 15%. Similarly, 97% of the males who were registered for certificate courses were in science related fields as compared to 52% of the female ones. However, at graduate level, the respective percentages were 9% and 17%.

In line with other educational institutions, the Lesotho College of Education (formerly the National Teacher Training College) also restructured its teacher training programmes to include courses leading to a Diploma in Technical Education. It is hoped that this will support the expansion of technical education in secondary schools in future although the throughput is still very low. In 2002, only 15 or 6% of the 268 students who obtained certificates and diplomas at this college had diplomas in technical education.

In 2002, there were 1980 Basotho students who were enrolled in degree courses abroad, 97% in the RSA. Of these, 41%[21] were registered for science and related fields, while the rest were registered either for social sciences or for humanities (figure 2). This large number of students studying abroad costs the country more than M100 million per year. This money could be saved with the expansion of science and technology training opportunities within the country. For this reason and to support human resources development and lay down a sound framework for economic development, including promoting indigenous technologies, a private initiative to establish an Institute of Science and Technology (IST) in Maseru is underway. According to plans, this institution will offer degree courses in engineering, the built environment, physical sciences, life sciences, management, and indigenous technologies. IST will put a lot of emphasis on the application of science and technology to stimulate economic growth and development, increase job opportunities, facilitate the upgrading and preservation of the environment, reduce poverty, and reduce imbalances in the access to opportunities.

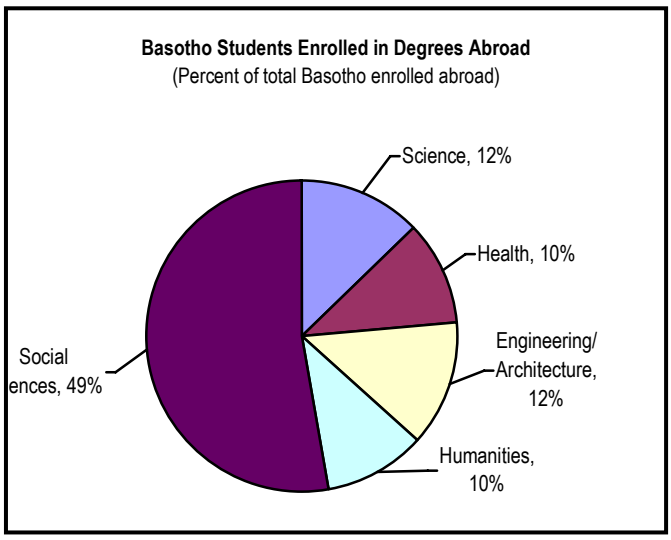

Figure 2

It has been difficult for Lesotho to develop and retain human resources within the country since it is totally surrounded by the RSA which offers higher salaries and better working conditions. Most of the young and more innovative Basotho who have been trained either inside or outside the country are often attracted to countries with better pay and appropriate infrastructure for their services, the RSA being the main beneficiary. The absence of job opportunities inside the country, and the orientation of education towards training for jobs as opposed to training for employment do not seem to help the situation.

Other related initiatives

Industrial training and support

The industrial base, the main engine for technological development, has remained relatively small in Lesotho. The two major parastatals that are responsible for industrial promotion are the Lesotho National Development Corporation (LNDC) whose mandate lies with the promotion of direct foreign investment and large-scale domestic industries and commercial centres, and the Basotho Enterprises Development Corporation (BEDCO) whose mandate is limited to the promotion of small and medium-scale indigenous enterprises. These institutions, particularly the LNDC, have made considerable progress in providing infrastructure (industrial estates) for both industrial and commercial development, making Lesotho one of the major exporters under the African Growth Opportunities Act (AGOA) of the United States of America, through attracting investments in clothing and textiles, footwear, and household electronics.

LNDC=s major objective is to promote Lesotho as an attractive investment location for both foreign and domestic investors. Its strategy includes a concession tax rate of 15% on profits, tax exemption on capital machinery and manufacturing equipment, provision of serviced industrial sites and factory shells, and a full rebate of duties on imports of raw materials for re-exports. On the other hand, BEDCO provides both commercial and industrial units at low rentals to indigenous entrepreneurs in most of the lowland towns.

There is very little vertical integration in Lesotho=s industrial development. Although poor resource endowment is recognised as the major reason, lack of technology and technical skills in the country

[21] 46% of the males and 37% of the females

remain severe constraints. To relax the latter constraint, the LNDC has been running a Skills Training Grant Fund where companies that embark on skills training are reimbursed either a fraction or all of their expenses. A number of parastatals also run industrial training courses. These include Telecom Lesotho, the Lesotho Electricity Corporation (LEC), and the Water and Sewerage Authority (WASA). In the private sector, many employees have received training under dealerships and franchises.

Small contractor training

One of the core strategies for spearheading economic growth in Lesotho involves the introduction of entrepreneurship training at the secondary school level and introduction of entrepreneurship-oriented internship programmes for maintenance contractors and industrial technicians. The former programme is in the pipeline while the latter is partially in progress.

The Department of Rural Roads (DRR) in the Ministry of Public Works and Transport runs a small-scale contractors training programme at its training centre in Teyateyaneng, 35 kilometres north of Maseru. At this centre, prospective Basotho contractors are trained in road maintenance and construction entrepreneurship. The success of this programme has enabled the DRR to start phasing out its direct maintenance programme in preference for out-sourcing. In fact out-sourcing has become one of the key strategies of promoting the growth of the private sector in Lesotho.

Skills training

Lesotho has instituted several skills training initiatives whose aim was to introduce appropriate technology for rural communities in the areas of agriculture, soil conservation, handicrafts, food preservation, sanitation, rural water supplies, rodent control, etc. Most of these initiatives were donor assisted. Despite their positive impacts, the application of these skills has not gone far beyond the life span of projects. The absence of a trades testing facility in the country with a broad range of areas to be tested has also frustrated many trainees.

One of the strategies to expand employment has been to open skills training centres to disseminate practical skills such as plumbing, brick-laying, plastering, roofing, welding, metal work, painting, etc. to those retrenched from the mines of the RSA and to unskilled rural people. Skills training centres were opened in Maseru (Lesotho Opportunities Industrialization Centre - LOIC), Thaba Tseka (Thaba Tseka Technical Institute) and Mohale=s Hoek (Ntlafatso Skills Training Centre) for this purpose. The performance of graduates of these institutions has been found to be very impressive both in the private and public sectors. The LHDA also operated two skills training centres for labourers who were employed on dam construction sites as semi-skilled artisans. However, this initiative only lasted for the duration of Phase 1A of the project.

Trades testing

One of the functions of TVED of the Ministry of Education and Training involves trade testing whereby those who acquire new skills through on-the-job training are given recognition for their achievements. The tests developed by TVED provide for Grade B and C testing in automotive mechanics, audio-visual production, bricklaying, carpentry and joinery, dressmaking, electrical installation, fitting and machining, panel beating and spray painting, plastering, plumbing, and welding. Private individuals pay a fee of M80 for Grade B tests, and M60 for Grade C tests. Attempts are currently under way to broaden the scope of trade testing. The issue is more pressing in the textile and clothing sector where substantial numbers of on-the-job trainees are employed as unskilled workers.

4. TECHNOLOGY NEEDS IN THE ENERGY SECTOR

Introduction

Like in many developing countries, energy consumption patterns in Lesotho exhibit traditional characteristics where the utilization of traditional sources (wood, dung, crop residues) is higher than that of conventional fuels (coal, oil, natural gas, electricity). The low level of industrialization as well as poverty are the main reasons for this state of affairs that has been blamed for a major portion of environmental degradation. The rising demand for biomas fuel sources, particularly wood, has been blamed for deforestation, soil erosion and land degradation, loss of soil fertility, declining agricultural production and productivity, and dwindling biodiversity. Despite this unsustainable demand pattern, lack of affordable energy alternatives and population growth indicate that biomas energy sources will continue to be main sources of energy in Lesotho for some time, particularly in the residential sector.

Estimates from the Department of Energy (figure 3)[22] show that Lesotho had a total energy demand of 32.67PJs in 2000. Of this demand, 71% was satisfied from biomas sources, 20% from petroleum sources, 5% from coal, and 3% from electricity. Liquid petroleum sources, on the other hand, satisfied a mere 1% of the energy demand. Biomas mainly comprises wood, shrubs, dung, and crop residues. Wood and shrubs are mainly gathered from natural forests, woodlots and community plantations, or purchased from importing merchants. Dung is normally collected from animal kraals or from croplands and rangelands. On the other hand, crop residues are collected from croplands after annual harvests. It is estimated that in 1999, Lesotho had a biomas energy consumption level of 23.23 PJs, with wood and shrubs accounting for 35% each, dung 24% and crop residues 6% of this biomas energy demand.

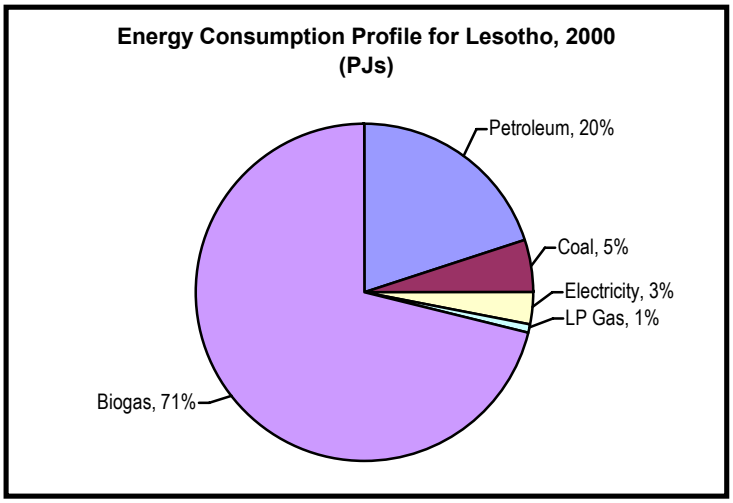

Figure 3

Table 2 shows household main energy sources for the years 1996 and 2001. It can be seen that in the 5-year period the percentages of households that reported wood and dung as their main sources of energy for cooking and heating increased, probably as a result of deepening poverty. During the same period, the percentage of those who were using electricity for cooking and heating declined. This was despite the fact that electricity is a cleaner and more convenient energy source. Many households used electricity merely for lighting as it made economic sense. While the percentages of households that used natural gas and paraffin for cooking increased slightly, the percentages of those that used these for heating decreased. Over the 5-year period, it appears that there was a gradual switch from coal to more convenient energy sources.

[22]Department of Energy, (June 2000) **Energy Policy Framework for the Kingdom of Lesotho**, table 1.1

Table 2 Percent Distribution of Households by Main Source of Energy and Application

Source of Energy	Population Census, 1996			Lesotho Demographic Survey, 2001		
	Cooking	Heating	Lighting	Cooking	Heating	Lighting
Wood	53.2	51.1	0.0	59.0	57.0	0.0
Dung	4.7	7.5	0.0	6.0	8.9	0.0
Coal	0.4	4.7	0.0	0.3	3.5	0.0
Electricity	1.3	1.5	3.5	1.0	1.2	3.7
Natural gas	8.4	1.9	0.6	13.7	1.5	0.5
Paraffin	30.8	31.9	51.5	19.2	26.7	55.3
Candle	0.0	0.0	43.8	0.0	0.0	39.2
Crop/other waste	1.2	1.3	0.7	1.0	1.2	1.2
Total	100	99.9	100.1	100.2	100	99.9

Sources: Bureau of Statistics and UNFPA (1996) **1996 Population Census Analytical Report,** IIIB, and Bureau of Statistics (March 2003) **2001 Lesotho Demographic Survey: Analytical Report**, Volume I.

The sector distribution of energy consumption shows that the residential sector accounts for 82% of the total demand. The transport sector comes second, accounting for 12% of total demand. This is followed by commerce and administration, accounting for 3%, and construction, with a demand share of 2%. The rest of the sectors accounted for a mere 1% of the total energy demand in the country. This distribution of energy demand in Lesotho therefore shows that the household sector provides an accurate depiction of the characteristics of energy consumption in the country.

Despite the promotion of cleaner and environmentally friendly energy sources, poverty compels households in Lesotho, particularly in rural areas, to increasingly depend on biomas energy sources, with detrimental impacts on the already troubled environment. On the other hand, Lesotho is almost totally dependent on imports for her requirements of liquid fuels, coal, and commercial fuel wood. There are 5 registered companies that import refined petroleum products from the RSA (British Petroleum, Engen, Caltex, Shell and Total) and distribute these throughout the country. In 1999, 83 million litres of petrol, 39 million litres of diesel, and 66 million litres of illuminating paraffin were imported. The country has a storage capacity of 6 days from its 3 depots in Maseru. Statistics also show that 3,500 tonnes of LP gas were imported by retailers in 1998. On the other hand, it is estimated that the country imported 54,400 tonnes of coal in 1999.

Studies have shown that Lesotho has a hydro-power potential of 450 megawatts (MW). However, only 17% of this potential is being exploited at the moment, 96% of it at the >Muela hydro-power plant and the rest from mini hydro-power plants at Mantsonyane, Mokhotlong, Tsoelike and Semonkong in the mountain heartland. Since the commissioning of the 72 MW >Muela hydro-power plant in 1999, the country is almost 100% self-sufficient in electricity supply. However, as the economy expands, generation capacity will have to be expanded or the country will be compelled to depend on imports to cover the emerging deficit. On the other hand, although Lesotho has 300 days of sunshine a year, current generation of solar energy is estimated at 65kW.[23] Photovoltaic systems have been used to power national communication systems, water pumps for rural water supplies, rural clinics, and a number of household activities. Studies are currently underway to assess the country=s wind energy potential.

[23]Department of Energy, (June 2000) **Energy Policy Framework for the Kingdom of Lesotho**, p.13

There are rural-urban differences in energy demand in Lesotho. In the rural household sector, almost 90% of the energy is derived from biomas sources (shrubs, firewood, crop residues and dung). However, paraffin is widely used for lighting and sometimes for heating and cooking. Only a handful of rural households are either connected to electricity or use solar energy or generators. On the other hand, the predominant energy sources for urban households are electricity, LP gas, liquid paraffin, coal and commercial wood. Administrative buildings and industrial establishments mainly use electricity and coal, while commercial establishments mainly use electricity, diesel, LP gas, coal and commercial wood. The motorised transport sector is entirely dependent on refined petroleum products for energy sources.

Challenging issues

The utilization of energy is intricately related to a number of other thematic issues that present themselves as development challenges in Lesotho. These include impacts on the environment and health and safety. Also featuring amongst these thematic issues are gender issues, poverty alleviation, and international cooperation. These issues become more challenging when considered against greenhouse gas (GHG) emissions as well as against prospects of future climate change.

The relationship between energy and the environment in Lesotho has been well elaborated in the state of environment report.[24] Energy-related environmental impacts, particularly in the rural sector, have been found to be directly related to the use of traditional biomas fuels as well as to widespread poverty. The removal of biomas for fuel has aggravated land degradation by exacerbating soil erosion and decreasing prospects for the replenishment of organic soil nutrients. On the other hand, poverty compels rural households to increasingly depend on unsustainable biomas energy sources such as wood, shrubs, dung, and crop residues.

The link between biomas fuel use, depletion of organic soil nutrients, land degradation, and poverty has compelled the government over the years to embark on tree planting programmes with a multi -objective to provide fuelwood, to reduce pressure on the limited biomas resources and release animal dung for utilization as manure. On the other hand, the utilization of biomas and fossil fuels is not only associated with the emission of GHGs but with a high occurrence of respiratory tract diseases. Many households, particularly in rural areas, burn these fuels in enclosed spaces that have poor ventilation, often using poor quality appliances, with severe risks on their health.

Energy sector challenges have been presented in detail in the framework paper referred to above. A summary of these is presented on table 3 below. The biggest challenge is to develop technologies that will encourage the utilization of sources of energy that are not only sustainable but environmentally friendly.

[24]Chakela Q. K. (Ed.) (1999) **State of the Environment in Lesotho 1997**, National Environment Secretariat, Chapter 13.

Table 3 Summary of Challenges Facing the Energy Sector

Sector of challenges	Nature of challenges

Household sector	$ to improve the choice of affordable energy options;
	$ to reduce indoor pollution resulting from the burning of biomas;
	$ to provide information on alternative energy sources; and
	$ to promote thermally-efficient dwellings.

Transport	$ to reduce pollution from vehicle exhausts; and $ to establish a reliable fuel supply.
Industry/Commerce/Government	$ to ensure competitive energy pricing; and $ to promote the efficient use of available energy

Biomas energy	$ to improve availability of biomas resources;
	$ to promote sustainable use of biomas resources;
	$ to protect and improve management of indigenous trees and shrubs; and
	$ to compile and update a data bank on availability and utilization of biomas resources.

Fossil fuels	$ to regulate coal imports;
	$ to promote awareness of alternative sources of energy;
	$ to reduce pollution resulting from coal combustion;
	$ to ensure availability and fair pricing of petroleum products;
	$ to ensure awareness of LP gas and paraffin; and
	$ to ensure participation by locals in the petroleum sector.

Electricity	$ to increase the level of electrification;
	$ to increase community involvement in the power sector;
	$ to promote energy efficiency and safe use of electricity; and
	$ to harvest benefits of regional cooperation.

Other renewable energies	$ to make renewable technologies more affordable and accessible;
	$ to improve information dissemination and public awareness;
	$ to reduce theft and vandalism of PV panels; and
	$ to develop and enforce standards of renewable energy systems.

Source: Department of Energy (February 2002) **Energy Policy Framework for the Kingdom of Lesotho: Energy Policy Summary**, Draft Version 4.

Sector Institutions

The energy sector stakeholders are quite varied, involving government agencies, non-governmental organizations, private companies, as well as individual households. The primary functions of formulating overall or national sector policies, drawing up long-term plans, coordination of sector activities, promoting certain technologies, monitoring sector performance and overseeing government projects lie with the Department of Energy in the Ministry of Natural resources. Working with this department are the Lesotho Electricity Corporation (LEC), the Appropriate Technology Section (ATS) of the Ministry of Local Government, private oil companies that mainly distribute imported petroleum products, the Lesotho Solar Energy Society, a non-governmental body that is registered for the promotion of solar energy, three private enterprises that design and install solar systems, several private LP gas dealers, and the Power Sector Policy Committee that is mandated to formulate power policies and to review, determine and publicise tariffs for petroleum fuels.

Overall policies and strategies

Since 75% of energy demand in Lesotho, representing mainly the cooking and heating needs of rural people, is satisfied from non-commercial indigenous sources (shrubs, crop residues, and dung) whose harvest has been closely associated with environmental degradation and poor soil fertility, policies in the energy sector have put a lot of emphasis on expanding renewable energy sources and implementing biomass development programmes. The main objective of sectoral policies is to provide energy to all sectors and regions of the country with minimum social, economic, and environmental cost. In this respect, the following policy strategies have been advocated:

- Development of indigenous energy sources;
- Substitution of imported commercial energy sources with alternative indigenous sources;
- Expansion of indigenous hydro-power generation and electricity distribution infrastructure; and
- Promotion of energy conservation in various sectors of the economy.

In 1988, the government embarked on a very ambitious initiative that involved the development of an energy master plan.[25] This plan set up targets for the energy sector that were somewhat unrealistic given the country=s available resources and institutional weaknesses. A follow-up to this exercise shifted attention to the development of a national energy policy, a 3-year exercise that culminated in an energy policy framework paper in June 2002. This policy formulation process started in 1999 with a stakeholder consultation. The specific objectives have been drafted to respond to the issues and challenges that resulted from this consultative process. The draft energy policy that has recently been concluded aims at ensuring that energy is universally accessible and affordable in a sustainable manner, with minimal negative impacts on the environment.[26]

The draft energy policy carries five major objectives:

- Contribution towards the improvement of livelihoods - The energy sector aims at contributing towards poverty alleviation by developing and disseminating affordable technologies and services, and by promoting income generating opportunities that sustain and improve the lives of the citizens;
- Contribution towards the protection of the environment - The energy system, which includes supply and consumption of energy resources as well as other related processes, should contribute towards environmental sustainability;
- Contribution to economic growth and investment - The energy sector aims at contributing to economic growth initiatives that emphasise efficiency and effectiveness in energy sector management and job creation. Emphasis is to be placed on the enhancement of conditions that encourage private sector investment;
- Ensuring access to basic energy technologies and services - A choice of affordable, reliable and quality technologies and services that will be sourced within the country and in the sub-region will be made available to all citizens; and
- Ensuring security of supply - The energy sector aims at ensuring that national requirements for energy from diversified sources are satisfied with safe and secure supplies that are subject to local regulations and regional agreements.

[25]GTZ and Lahmeyer International (1988) **Lesotho Energy Master Plan**, Ministry of Water, Energy and Mining

[26]Department of Energy (To be published) **Energy Policy for the Kingdom of Lesotho** (Draft), p.3

Table 4 Energy Policy Strategies by Category

Policy Category	Thematic issue	Policy strategies
Energy supply	Biomas	$ Implement reforestation programmes $ Protect indigenous vegetation
	Electricity	$ Attract private investment $ Accelerate programme of national electrification $ Promote local participation in the design, planning and implementation of electrification projects
	Petroleum & gas	$ Ensure security of supply $ Ensure availability, affordability and equitable distribution of supplies and appliances $ Promote local participation in downstream industries
	Renewable energy	$ Improve affordability $ Investigate utilization for income-generating activities $ Enhance public awareness of technologies $ Provide information about costs and benefits
Regulation	Energy supply	$ Target subsidies to the urban and rural poor $ Adopt transparent and economic energy pricing policy $ Introduce regulatory body to monitor and regulate price developments
	Public services	$ Maintain public service obligations within a privatized sector
	Training obligations	$ Ensure oil industry compliance with training obligations
Energy Efficiency	Electricity supply	$ Promote safe and efficient use
	Cooking and heating	$ Investigate, identify and promote the appropriate fuel-efficient cooking and heating technologies
	Energy conservation	$ Promote construction of thermally-efficient homes $ Promote use of energy-efficient household appliances $ Collaborate with industry and commerce to reduce barriers to investment in energy-efficient practices and equipment
Information	Awareness campaigns	$ Awareness campaigns to promote efficient and sustainable use $ Awareness campaigns on different energy sources, appliances and energy conservation measures $ Awareness programmes on the use of LP gas and coal. $ Update available information on the biogas resource base and end-use patterns
Gender	Burden reduction	$ Conduct surveys and studies to determine impacts of energy practices and devices
Environment	Compliance	$ Participate and contribute to the international dialogue on climate change through the UNFCCC and its protocols $ Monitor compliance with national environmental laws $ Investigate possible environmental impacts of practices and appliances $ Promote the use of cleaner energy sources and technologies $ Discourage the use of energy sources that contribute to pollution
International and regional cooperation	Cooperation	$ Source economically competitive and reliable international or regional energy options $ Strengthen cooperation with the Southern African Power Pool and enforce compliance with the agreement thereof.

Source: Department of Energy (February 2002) **Energy Policy Framework for the Kingdom of Lesotho: Energy Policy Summary**, Draft Version 4.

Table 4 shows a summary of major or thematic policy issues and strategies that have been advocated in Lesotho=s draft energy policy. The Department of Energy (DOE), the focal point for policy formulation, is

merely involved in sector coordination activities and therefore will find it difficult to ensure successful implement of the above policy objectives, let alone to enforce issues in an environment that involves a multiplicity of both public and private sector institutions that have divergent interests. Despite the undertaking to create opportunities for local research institutions to carry out relevant energy-related research by providing funding and/or identifying external sources of funding, capacity constraints will remain a severe limitation to policy implementation.

Options for Technology Transfer in the Sector

Technology transfer initiatives in the energy sector have largely been confined to the expansion of renewable energy and energy conservation. Other than biomas and hydro-power, renewable energy currently plays a minute role in the economy. On the other hand, since less than 5% of the households have access to grid electricity, renewable energy could play a very important role in meeting household energy requirements. In addition to hydro-power development, there have been a lot of efforts to develop and disseminate photovoltaic systems and appliances such as solar water heaters and cookers and solar dryers. In addition, experiments on biogas digesters and wind energy generation are still in progress.

It is also common knowledge that if energy is utilised more efficiently, significant financial, economic, environmental and social benefits can be achieved. The promotion of effective and efficient use of energy in the economy is therefore seen as a logical development strategy in Lesotho. The focus is currently on the household sector, industry and commerce, government buildings and transport. In this respect, attempts are underway to introduce energy auditing as a tool in energy management, to introduce energy-efficient technologies such as energy-efficient cooking devices/stoves, to introduce passive solar design in buildings, and to encourage fuel switch to more efficient energy sources.

Renewable energy technologies

The most promising renewable energy source in Lesotho is hydro-power although most of the emphasis in recent years has shifted to the development of solar energy - the development and dissemination of fruit dryers and solar cookers, and the dissemination of photovoltaic systems. On the other hand, other than electricity and biomass, the utilisation of other renewable energies such as solar power, wind energy, and biogas is not widespread although their promotion continues through the ATS. There is also a private company that is disseminating solar cookers, solar water heaters, solar dryers, and photovoltaic systems. The latter is the most popular solar energy source with households. Unfortunately, available designs of solar water heaters are generally those that rely on piped water to which many rural and peri-urban households have no access. It is hoped that increased adoption of solar energy will improve considerably with the establishment of a local testing facility for photovoltaic technologies.

In the development of renewable technologies, emphasis is placed on the development of affordable devices that are not only locally serviceable but are of quality standards. Attempts are therefore underway to develop regulations that will guide the development and marketing of these renewable energy technologies, to organise financing mechanisms that are suitable for economic conditions in Lesotho, and to investigate possibilities of removing levies on imported renewable energy technologies. Support initiatives for the utilization of renewable energy technologies for income generating activities are under investigation, as are possibilities of the establishment of capacity for the maintenance of renewable energy installations.

Other strategies to promote renewable energy technologies include undertaking awareness campaigns using different types of media such as radio, establishment of demonstration units, and expansion of training programmes and school curricula to accommodate renewable energy technologies. Despite these efforts, there are constraints that lower the rate of adoption. These include low affordability due to high initial investment costs, poor workmanship during installation, lack of qualified maintenance personnel, and inadequate information and public awareness.

Hydro-power development

Studies have shown that the potential hydro-power energy supply in Lesotho stands at 1260GWh per year,[27] more than 6 times the size of the current electricity demand in the country. Although studies on hydro-power generation possibilities started in the 1970s, resulting in an identification of 26 sites, it was not until mid-1980s that work started on the construction of 4 mini-hydro schemes that had a combined generation capacity of 3.5MW. These were designed to meet the power needs of isolated mountain communities. One of these schemes is now connected to the national electricity grid, while the other three are standalones. The latter have since become a financial burden due to droughts, sedimentation and low load factors, making the proposition of mini-hydro schemes not a very attractive one.

The country made a big leap at the commissioning of the M1.3billion >Muela hydro-power component of the Lesotho Highlands Water Project (LHWP) in August, 1998. With a generation capacity of 72MW, this plant represents a very successful strategy in import substitution by providing the country for the first time with almost all its demand for electricity, and by creating income possibilities from limited electricity export sales. This expansion of the local hydro-power generation capacity has improved Lesotho=s opportunities and flexibility in the distribution of clean energy to under-served communities. There are plans to continue with the investigation of the hydro-power potential of the country and to explore options for further development.

The main actor in the electricity sub-sector is the Lesotho Electricity Corporation (LEC), a parastatal institution that purchases and distributes electric power from the Lesotho Highlands Development Authority (LHDA) owned >Muela hydro-power plant, with a peak backup arrangement with Eskom in the RSA. The institution also generates electricity from mini-hydro power stations, some of which have diesel operated back-up plants. The LEC operates a national reticulation grid that largely covers urban and a few rural areas, with a connection to the Southern African Power Pool (SAPP). It also manages the government=s rural electrification programme.

At the present moment, less than 5% of the households in Lesotho are connected to the LEC=s network. In order to expand the coverage and improve the management of the sub-sector, an electricity master plan was drawn up in 1996 and approved as an official document in 1997. This plan envisaged in its medium-term scenario a growth in electricity consumption of 5% per annum up to 2003. This would be made possible through the adoption of the following strategies:

- Deregulation of the sub-sector in order to allow competition in the supply of electricity, a strategy that would allow the entry of new investments, particularly in electricity distribution, and provide greater incentives for improvements in efficiency;
- Introduction of private sector participation in the sub-sector in order to increase the amount of resources that are available to meet the sub-sector=s needs and promote the transfer of technology;
- Implementation of institutional reforms that would include rightsizing and privatisation; and
- Re-balancing of the tariff structure with the aim to reduce prices facing the industry, and to promote new connections.

There was slow progress in implementing the electricity master plan due to low funding and limited technical resources. However, the following activities that were aimed at putting the electricity sub-sector on a sound financial footing have been successfully completed:

- Defining modalities for the disposal of surplus electricity through the Southern African Power Pool (SAPP);

[27]Khalema, L. ***Rural Electrification in Lesotho*** in Ranganathan. V. (1992) **Rural Electrification in Africa**, Zed Books Ltd./AFREPREN, Gaborone, p.148.

- Reviewing the legal and regulatory framework in order to allow more actors in the electricity sub-sector and to enable the establishment of a Power Regulatory Authority;

- Fast-tracking the implementation of electrification projects (still in progress after a number of rural areas were surveyed for electrification during the master plan period);

- Restructuring of the LEC not only with the aim to prepare for private sector participation by out-sourcing non-core activities, but to transform it into a financially viable and effective organization that is capable of attaining the set goals; and

- Concretizing refinancing proposals for the >Muela Hydro-power Scheme with the objective to make electricity more accessible to the rural poor.

Solar photovoltaic technologies

Solar energy technologies like solar water heaters, solar crop dryers, solar cookers and solar (photovoltaic) electricity have been promoted in Lesotho for close to three decades, albeit with different emphasis for different technologies. With an estimated more than 300 days of sunshine per year, the potential for solar energy development is unquestionable despite the fact that in terms of energy value there will always be variations from locality to locality. Although there is no manufacturing of solar photovoltaic (PV) system components in the country, widespread applications have been recorded in homes, clinics, schools, water pumping and telecommunications. There are also potential applications in cottage and small-scale industries, including small-scale agriculture.

In 2002, the Department of Energy[28] estimated that about 3,146 households or 1% of total rural households used solar home systems, with a total installed capacity estimated at 11,000W_p. The total number of systems installed throughout the country was estimated at 4,000. Although to a small extent, solar PV competes with kerosene and candles for lighting and with dry cell batteries or automotive batteries for powering radios and TVs. Solar PV systems with a total installed capacity of 8,000W_p were also installed at 32 clinics that are located in remote parts of the country where there is no electricity. Although these had lower running costs compared to diesel operated generators, they were generally said to be in a poor state of maintenance, with many out of operation.

So far there are 3 registered solar PV dealers in the country. The Department of Energy has developed a code of practice for the installation of PV systems at household level although there is no mechanism for enforcement. This code, prepared with the full participation of solar dealers, covers lighting and TV powering. Unfortunately, it is only closely followed in government contracts where its use is mandatory for effecting payments to contractors. On the other hand, the application of solar PV systems in water pumping has largely been limited to operations of the Department of Rural Water Supplies (DRWS) although there are a few cases of individually owned systems. In 2002, DRWS had 35 installed systems with a total estimated capacity of 21,000W_p. However, only 11 systems were operational due to theft and vandalism. These problems are also experienced by Telecom Lesotho which has 18 solar PV systems with a total installed capacity of 23,000Wp to power their telecommunication equipment at various sites in the country.

Solar thermal technologies

Solar thermal technologies have been applied in solar water heaters, solar cookers, solar dryers, and in passive solar designs of buildings.

Solar water heaters

In 2002, about 500 solar water heater systems with a total capacity of 0.22MW had been installed in government hospitals, at clinics, and in some private hospitals. Most of the hospital systems had

[28]Department of Energy, (June 2000) **Energy Policy Framework for the Kingdom of Lesotho**, p.36

electricity back-ups although they were said to be in a poor state of repair due mainly to poor workmanship and maintenance standards that were unsuitable for local conditions. In the residential sector, solar water heaters are of limited application as they are only suitable for houses that are fitted with electric geysers. Affordability also remains a challenge.

Solar Cookers

Solar cookers that were developed by the ATS through the Renewable Energy Technologies Project (RET) are now commercially produced by the Bethel Business and Community Development Centre in the Mohale=s Hoek District. Solar cooker technology has the potential to reduce the burden of fuel expenses and relieve pressure on biomas resources. However, their adoption by households has been rather slow. The reason is the concentration of the availability of the energy and therefore device effectiveness at mid-day, yet demand for cooking energy is higher either in the mornings or in the evenings. However, most of the schools in Lesotho run school feeding schemes where cooking is done at mid-day. It is here where the potential for the application of the solar cooker technology lies.

Solar dryers

This device was introduced by the Thaba Tseka Rural Development project in the 1970s and later development by the RET Project in the 1980s and early 1990s. This dryer technology has the advantage of protecting food from dust, rain, wing, insects, and animals. Not only is awareness of the food dryer low, but demand for the device is higher than supply for those who happen to be aware since the ATS has been producing a mere 70 units per annum. Attempts are underway to identify prospective manufacturers of this device that is very suitable for Lesotho conditions where food production tends to be seasonal.

Wind energy

About 43 low-speed water pumping windmills were installed in rural Lesotho in the 1970s and 1980s by the then Village Water Supply section of the Ministry of Community and Rural Development with the objective to supply portable water to rural communities. The technology encountered problems owing to lack of spare parts. On the other hand, most of the sites for these wind pumps were located on low lying areas where water was available, but where wind was a scarce resource. As a result of these constraints, the programme of harnessing wind energy for pumping water for rural communities in Lesotho was phased out.

Wind speeds have been measured at airports in Lesotho at heights of 2m above ground. While this height is adequate for weather predictions by the Department of Meteorological Services (DMS), it is not appropriate for the full assessment of wind energy potential, particularly for electricity generation where high speeds are required. In 2001, a programme of measuring wind speeds at appropriate heights was jointly initiated by the DOE and DMS with the main aim to assess wind energy electricity generation potential although the results are not yet published. Initial indications show that potential for wind electricity generation exists in the country since wind speeds that were taken from 13 stations that were installed prior to 2002 resulted in a mean value of 2.3m/s.

Biogas technology

Biogas technology is used to transform organic waste into gas and fertilizer by using anaerobic processes. The first efforts at introducing this type of technology in Lesotho were made in the early 1970s and early 1980s. About 80 biogas digesters were built all over the country following designs that were mainly of Chinese and Indian origin. Unfortunately, most of these plants are now out of commission due to inadequate preparations, lack of product support professionals in the field, and inadequate adaptation of the technology to local conditions. In the early 1990s, only 6 of the plants were still operational. However, stakeholders' consultations suggest that the technology has to be revisited. Different promotion strategy options, including experience sharing with countries such as Tanzania where the technology has been successful, will have to be explored. In addition, the production of biogas in facilities such as landfills and sewerage treatment plants has to be explored.

There have been private efforts at reviving biogas technology by the Coordinator of the German Development Service. As a start, a demonstration plant was established in Maseru in January 2003, after which 7 people were trained as biogas technicians. So far 30 biogas digesters have been built by this group in 3 districts - Maseru, Qacha=s Nek, and Quthing. About 50% of these digesters have already been commissioned. The current digesters have been redesigned to reduce possibilities of leakages, to use a wide range of organic waste, and to reduce the demand for labour.

Energy Conservation

The demand for space heating in Lesotho is very high in winter due to severe temperatures. The key challenge is to encourage greater energy consumption efficiency in all sectors of the economy with the hope that this could lead to financial savings that could be invested in other areas of the economy that are in greater need such as social development. Activities in energy conservation have mainly focussed on the improvement of building designs and the development of heat conserving, energy-efficient technologies (retained heat cookers, metal stoves, and stone braziers (*paola*s)). The demand for investments in other sectors of the economy could be met from solar gains that accrue from proper building orientation, as well as by adopting appropriate architectural designs, including the use of thermal insulation.

The Department of Energy has developed guidelines for energy-efficient buildings. However, the existence of an informal property market in rural and peri-urban areas where there are no regulations governing building plans and construction, lack of enforcement of building regulations in urban areas, extra costs that are associated with some energy conservation measures, and the absence of established property developers pose serious constraints to the adoption and incorporation of these guidelines. A new strategy to disseminate the guidelines through programmes of technical and vocation schools is being examined.

Energy efficiency/conservation in the residential sector

Public awareness about technological advancements and appropriate daily practice aimed at realising energy and thermal efficiency as well as energy conservation is very low in Lesotho. This is because of lack of information and opportunities for education in these critical areas. In the design of residential buildings, many households seem to prefer glamour and appearance as against energy efficiency and comfort levels. The residential sector has not shown a widespread adoption of sustainable building practices and use of energy efficient household appliances in order to reduce household energy requirements. In order to advance this awareness, the draft policy on energy advocates to:

- Develop incentives-based mechanisms to encourage architects, developers and commercially and self-help based builders to construct thermally-efficient homes;

- Collaborate with utilities, manufacturers and retailers to ensure that energy-efficient appliances are available on the market; and

- Assess the feasibility of establishing an appliance labelling programme.

Energy efficiency/conservation in commerce and industry

Although there is no hard evidence, the current opinion in official circles is that excessive energy consumption of energy in commerce and industry results from inadequate heat retention techniques or insulation. Many managers are also said to be reluctant to install energy-efficient equipment because of high up-front costs that are associated with the relevant equipment. The strategies that are advocated in the draft plan include;

- Collaboration for the removal of barriers that inhibit investments in energy-efficient equipment and practices;

- Ensuring that management aids such as load management and efficiency monitoring are available and affordable;

- Tendering energy audits and advice on energy management techniques upon request; and
- Promote development of fuel-efficient technologies and practices.

Energy efficiency/conservation in the transport sector

The objective of fostering energy efficiency and conservation in the transport sector is to reduce traffic congestion on Lesotho=s limited road infrastructure, reduction of transport costs, and improve health by reducing local air pollution. Although the extent of the problem is not well documented, the following actions are being advocated:

- Development of information and educational material on the efficient use of transport alternatives; and
- Encouragement of investments in and use of public modes of transport.

Energy efficiency/conservation in government buildings

Public buildings consume large amounts of energy, particularly for space heating in winter. The amount is augmented by poor thermal efficiencies and a widespread lack of effort to manage consumption. There is no doubt that energy savings in this respect would have a very positive budgetary impact. Efforts are already underway to effect energy savings in public transport by reducing the number of public vehicles on the roads. Similar controls could be applied to space heating. Possible steps here could include the following:

- installation of energy-efficient equipment;
- Creation of incentives for public servants to utilize energy efficiently and sustainably;
- Conducting of energy audits in government buildings; and
- Construction of new buildings on new energy management principles.

Passive solar design in buildings

Architecture in Lesotho is such that houses are not thermally insulated or built to maximize solar gains. Consequently all the heating requirements are through auxiliary means. The construction of buildings according to the principles of passive solar design and thermal insulation should lead to a reduction of the need for auxiliary heating, and to lower energy bills. It is estimated that 60% of the commercial energy used for space heating could be substituted with passive solar heating.[29]

Energy efficient cooking devices/stoves

Improved stoves have been developed and promoted by ATS for more than three decades. However, an adoption study[30] commissioned by DOE in 1993 indicated that the stoves were not unaffordable for many households. They also exhibited poor aesthetics in comparison to those that were traditionally available in the market. As a result of these findings, it is not anticipated that any aggressive programme of improved stoves promotion will be implemented in the near future.

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[29]GTZ (July 1991) Lesotho: **Energy Master Plan Update: Draft Summary Report**, Department of Energy, Maseru

[30]Gay, J. et al (May 1993) **Renewable and Conservation Energy Technology in the Kingdom of Lesotho: A Socio-economic Study of Constraints to Wider Adoption by Households and in Residential Buildings**, Department of Energy.

Energy auditing

Energy auditing is a relatively new concept in Lesotho although fragmented energy audits have been carried out in the past. In 1987, the Southern African Development Community (SADC) initiated a programme that aimed at investigating the prospects for energy conservation through energy audits amongst member states. The findings indicated that there was potential for energy conservation in the region. As a result, a programme of enhancing the capacity of industries in the region to improve energy management through energy auditing was conceived. A few industries and institutions benefited from this programme which also assisted a local institution, the Lerotholi Polytechnic, to start a programme of energy management for industry personnel.

5. TECHNOLOGY NEEDS IN THE LAND-USE CHANGE AND FORESTRY SECTOR

Introduction

Land-use patterns in Lesotho have largely been determined by historical circumstances and agro-ecological conditions. Hilltops and mountain sides were used as fortresses during territorial wars of the 19th Century; hence many settlements were confined to these strategic locations while plains and fertile valleys were devoted to crops, and the remote mountains to grazing. This has largely remained the pattern of land-use in the country although population pressure and the need to move away from remoteness have forced widespread encroachment of settlements onto areas that were traditionally reserved for agriculture. On the other hand, the shortage of agricultural land has also forced the cultivation of mountain slopes (marginal lands), with devastating results on soil stability, the quality of the range, and agricultural productivity.

Although somewhat outdated, table 5 shows land classification/use categories in Lesotho. It can be seen that the most predominant classification is grazing, providing forage for the country=s 709,884 cattle, 1,116,629 sheep, 830,258 goats, 96,738 horses, 179,948 donkeys, 1,283 mules, 103,700 mostly free ranging pigs,[31] and an unknown number of wild ungulates. The second most dominant land use is cropping. This occupies 24.7% of the total land despite the fact that arable land is estimated at a mere 9%, the shortfall being satisfied from the cultivation of marginal lands. The seriousness of land degradation is demonstrated by the fact that 1.9% of the land area is classified as dongas. It is widely thought that the classification Arock outcrops@ is expanding rapidly as a result of erosion. On the other hand, although villages occupy 3.2% of the land area, they are known to be encroaching fast onto croplands, resulting in increases in landlessness and resort to the cultivation of marginal lands.

Table 5 Land Classification/Uses in Lesotho, 1988

Land Classification/Use	Area (Ha)	Percent of Total
Croplands	754,002	24.7
Range	1,981,896	64.8
Forest	12,118	0.4
Rock outcrops	103,798	3.4
Gullies	59,572	1.9
Villages	98,802	3.2
Roads	12,118	0.4
Water	33,179	1.1
Other	1,581	0.1
Total	3,057,066	100.0

Source: Chakela, Q. K. (Ed.) (1999) **State of the Environment in Lesotho 1997**, National Environment Secretariat, Chapter 9 table 9.1.

The situation that has been described above has been blamed for extreme forms of land degradation, including very spectacular forms of soil erosion that are found in Lesotho today. It is estimated that the country loses a total 40 million tons of soil per year through gully, sheet, and rill erosion.[32] Since 85% of the population in Lesotho is classified as rural, the importance of the land resource cannot be overestimated. However, factors that have exposed the country to severe soil erosion (topography, the variable rainfall pattern, animal and human pressure, the cultivation of marginal lands, poor land management practices, etc) threaten the stability of this livelihood source, compelling Lesotho to perpetually depend on food imports and food donations.

[31]Statistics from Bureau of Statistics/FAO (Undated) **1999/2000 Lesotho Agricultural Census Volume II - Rural: Livestock Statistics**.

[32]Conservation Division (1988) **National Conservation Plan**, Ministry of Agriculture, Cooperatives and Marketing

Agriculture

As land use problems intensify in Lesotho, agricultural production and productivity have been the biggest casualties, falling far below those in the neighbouring Free State Province of the RSA where agro-climatic conditions are very similar. Over the years, project trials have shown that the country=s crop yields could be improved provided appropriate technologies are introduced. One such technological innovation by the Land Use Planning Department[33] has involved the development of a comprehensive reference for all field crops and vegetables through the matching of detailed agro-ecological characteristics and data from detailed soil surveys (table 5) with crop cultivars. For each agro-ecological zone, recommendations are made in terms of crop suitability, planting dates, seeding rates, fertiliser requirements, pest control, and harvesting.

Table 5 Summary of the Characteristics of Lesotho=s Major Agro-Ecological Zones

Parameter	Lowlands	Foothills	Mountains	Senqu River Valley
Area (km^2)	5,200 (17%)	4,588 (15%)	18,047(59%)	2,753 (9%)
Altitude	1,00-1,800 metres	1,800-2,000 metres	2,000-3,250 metres	1,000-2,000 metres
Topography	Flat to gentle rolling	Steeply rolling	Very steep bare rock outcrops and gentle rolling valleys	Steeply sloping
Soils	Sandy textured, red to brown in the north clayey in the south	Rich, alluvial along valleys, thin and thick rock on slopes	Fragile, thin horizon of rich black loam except in valley bottoms	Calcareous clayey red soils with poor penetration by rainfall
Climate	Moist in the north, moderately dry in the south	Moist, sheltered	Cold, moist	Dry
Risks	Parching sun, strong winter winds, hail, periodic droughts, high soil erodability.	Floods, high soil erodability	Long period of frost, snow, hail, high soil erodability	Severe drought, moderate soil erodability.
Main crops	Maize, wheat, beans, vegetables	Maize, wheat, peas, fodder crops, potatoes	Maize, wheat, peas, potato	Maize, sorghum, beans
Vegetation	Crop stubble, reforestation on some hills, fruit trees near homesteads	Poplar and willow trees along streams and gullies, crop stubble, a lot of fruit trees near homesteads	Denuded grassland, indigenous shrubs in some river valleys, stunted peach trees near homesteads	Denuded dry shrubs, brush, few fruit trees in valleys
Summer Grazing	Around villages	Around villages	High mountain cattle posts	Unsuitable, too dry
% of livestock-rural:				
- cattle	47%	15%	33%	5%
- sheep	29%	6%	61%	4%
- goats	27%	14%	48%	11%
- pigs	60%	19%	14%	7%
- horses	27%	14%	55%	4%
- donkeys	50%	14%	31%	5%

Source: Adapted from FAO (February, 1996) **Lesotho: Sustainable Mountain Area Agriculture Development -Inception Report** and Bureau of Statistics (1999/2000) **Lesotho Agricultural Census** Volumes I, II, and III.

With a population growth rate of 2.8% and an accelerating problem of soil erosion and land degradation, there is growing pressure on the government to use the remaining arable land more productively, implying

[33]The land inventory and suitability classification was carried out by the Land Use Planning Department of the Ministry of Agriculture, Cooperatives and Marketing using the FAO=s **Guidelines on Land Evaluation for Rain-fed Agriculture**.

that it is necessary for the full genetic potential of each cultivar to be realized by ensuring that it is grown under conditions that are as close to ideal as possible. Attempts at agro-ecological condition/soil/cultivar matching have not progressed fast due to shortages of technical skills. Other approaches have included promoting the use of kraal manure, soil liming, crop densification, multiple cropping, irrigation, etc. Unfortunately, most of these innovations have not been sustainable due to, among many reasons, financial limitations on the part of the farmers, inadequate extension services, and erratic climatic conditions.

Despite agriculture=s sensitivity to climatic conditions and its declining share of the economy in recent years, it remains a major source of livelihood for over 80% of the population, providing employment to over 60% of the labour force. There is a dire need, therefore, for technological breakthroughs in the agricultural sector to expand employment and incomes and avert increases in poverty that are likely to be brought by climate change and population growth.

Rangelands

It has been shown on table 5 that 59% of Lesotho=s land surface is mainly utilised for grazing and, in recent years, for the provision of water for export and for electricity generation for local consumption. In fact the livestock sub-sector is less prone to erratic climatic conditions than arable agriculture. However, its productivity has been severely undermined by the country=s failure to adopt an appropriate balance between range resources and animal populations and by adherence to traditional management practices that include keeping livestock for non-economic reasons.

Range resources are communally held in Lesotho, a management practice that has been blamed for overgrazing and the resultant land degradation. In communal land utilization, farmers maximise individual benefits by holding large stock numbers, making it difficult to maintain appropriate stocking rates. The resultant reduction in the nutritional value of rangelands has resulted in low birth weights across all categories of livestock, low reproduction rates, high mortality, low carcass and fleece weights for small stock, and low incomes for farmers. Although in the past the country has advocated for de-stocking, culling and breed improvement, these have not been sustainable. On the other hand, the promotion of small-scale intensive livestock production is facing stiff competition from the RSA where economies of scale are higher, and where feed prices tend to be lower.

Although there is no general agreement on the level of overstocking, there is a consensus that Lesotho=s rangelands are in a poor and declining condition, with widespread erosion of the top soil, and an abundance of unpalatable and less nutritious species. There have been a lot of disparities in carrying capacity data in the country due to inaccuracies in livestock statistics and differences in methodologies of assessing rangelands carrying capacities. However, there is a general consensus that despite the government=s donor assisted programmes in recent years, there have been neither dramatic declines in livestock numbers nor significant improvements in range management, the main reason being that livestock is mainly kept for social as opposed to commercial reasons. On the other hand, a trend that is visible in contemporary statistics is one that shows a decline in the output of livestock and quality of livestock products over time.

Biodiversity

Lesotho boasts a biodiversity of specific endemism that is mainly found in the mountain region where 4,482 species of the Afro-Alpine and Afro-Montane plants and animals have been identified. This high occurrence results from variations in soils, the undulating topography, and micro-climatic differences that are found in each ecological region. However, protracted droughts and advancing desertification have encouraged the spread of Karoo invader species such as Rhus and Leucosedea, which today constitute 16% of the vegetation cover in the country. On the other hand, the biggest threat to Lesotho=s diversity remains human activity. Other threats to Lesotho=s biodiversity include desertification with associated loss of biological diversity and land degradation, the siltation and drying up of many rivers and their sources, increased aridity and disappearance of wetlands and marshlands, accelerated soil erosion and associated loss of soil fertility, and reduced vegetation cover. Since the establishment of NES, the government has mounted environmental awareness campaigns that emphasize species conservation, particularly through seeding programmes.

Forestry production

There is no comprehensive and update data on the extent of forest cover in Lesotho, with historical records showing that forests were limited to short patches under escarpments and to some river valleys in the mountains. On the other hand, although indigenous forests are of low occurrence, they are an important resource to rural communities by providing fuelwood, construction materials, forage for livestock, medicines and shelter. For many years it has been quite apparent that the utilisation of indigenous forest resources is unsustainable. As a result, efforts to reduce the rate of depletion were initiated in the late 19th century by colonial governments, with emphasis on providing for wood as well as for soil conservation. Today=s forest reserves comprise trees that were planted in the lowlands and foothills through the government=s soil conservation and woodlots programmes from the early 1970s. Although more than 10,000 hectares were planted, only 60% of this is known to be currently stocked.

Despite harsh climatic conditions and problems of animal and human pressure on forest resources, the government recognises the important role that trees play in soil stabilisation and sustainable land management, in providing shelter from destructive winds, in improving the water holding capacity of catchments, in providing fuel needs of rural communities, in providing building materials, and in improving aesthetics. However, there are constraints facing current intervention programmes. These include protracted droughts, inadequate funding and associated poor participation by the private sector, the communal land tenure system, destruction by wild fires and animals, vandalism by communities, and inaccessible sites. Not withstanding these and other problems, reforestation provides Lesotho with the only realistic means of attempting to meet future rural energy demands.

Lesotho has several Apioneer@ tree and shrub species that are capable of colonising open or degraded land, but only one or two Aclimax@ tree species whose seedlings can only survive in heavy shade. In most parts of the country, it is almost impossible to follow the full sequence of plant succession from pioneers to climax forests, woodlands, or shrub lands due to interruption by forest fires, cutting by people, or overgrazing by livestock.[34] A forest arboretum was established in Maseru in 1989 in order to sensitize people about the importance of indigenous forests, hence their protection. The tree and shrub species in this arboretum have been raised to over 100 in recent years.

The institutional framework

The intricate relationship between human activities and land degradation in Lesotho, particularly the growing needs of the population and its demands on the fragile land resource, compelled the colonial government to establish the Soil and Water Conservation Division of the Ministry of Agriculture in 1937. A further realisation of the importance of conservation in the overall management of natural resources, and the need for a more comprehensive approach to land-use planning, led to the establishment of the Lands, Surveys and Physical Planning Department (LSPP) in the Ministry of Interior in 1972, and the Land-use Planning Division (LUPD) in the Ministry of Agriculture, Cooperatives and Marketing in 1981.

The function of LSPP was to undertake physical planning in both urban and rural areas whilst that of LUPD involved the planning of agricultural land use. These two departments have now merged into a single department under the Ministry of Local Government. The latter also houses the Department of Chieftainship Affairs, an institution that occupies a central role in the utilisation of rural land resources at the community level through a network of traditional leaders and the geographical areas that they control. This ministry has been involved in efforts to operationalize democratic local government for several years. It is envisaged that in future local governments will be involved in land use planning within their own areas.

Within LSPP, the Physical Planning Division is charged with the responsibility of developing spatial plans that ensure optimum, efficient and planned spatial development throughout the country. Although 12 plans

[34]May E. D. (2001) **The Indigenous Trees and Taller Shrubs of Lesotho as Grown in the Forest Arboretum: their Distinguishing Characteristics, Distribution and Initial Growth**, Forestry Division, Ministry of Agriculture, Cooperatives and Land Reclamation, p.3.

were developed in the late 1980s through SIDA assistance, there has been no noticeable implementation due to lack of resources, as well as due to inadequate authority to enforce plans. On the other hand, the LUPD was charged with providing professional planning assistance to various technical divisions of the Ministry of Agriculture, and establishing a permanent land use planning service to local communities
.
In the late 1980s and early 1990s, the LUPD developed community land use plans in rural Lesotho through a strategy that involved village communities in identifying and delineating planning areas, identifying natural resources management problems and other development issues in those areas, and proposing solutions to these. The aim was to put local institutions at the forefront of local resource management programmes under the Ministry of Agriculture (MOA). Although 11 community land use plans were developed, there is no evidence that these plans were integrated into land resource allocation and management programmes of the MOA, the main reason being weak linkages between the LUPD and village development committees.

There are many other institutions whose operations have direct relevance to land use planning. The National Environment Secretariat (NES) was set up in 1994 to coordinate and integrate environmental issues in all sectoral activities, projects and programmes on a day-to-day basis. To strengthen this institution, a number of legal instruments have since been passed, enabling NES to enforce compliance. On the other hand, a number of departments within the Ministry of Agriculture are directly involved in land use issues, particularly those relating to the curbing, if not the reversing, of land degradation. In fact, in order to more effectively deal with land planning and management issues, this Ministry has been divided into two: Agriculture and Food Security and Forestry and Land Reclamation. Actions in land use change have mainly centred on improving the management of land use as well as on biomas production.

The Ministry of Tourism, Environment and Culture is also putting a lot of emphasis on nature based tourism, with product development that includes nature conservation and the preservation of the country=s cultural heritage. It is expected that in future, most of these efforts will fall within the realm of competences of local authorities. There is growing concern that uncontrolled growth of settlements, rural road construction activities, the cultivation of marginal lands, labour-intensive mining, etc have deleterious impacts on the environment and therefore efforts must be made to control these activities.

The policy and legal framework

There is no consolidated policy on land use planning in Lesotho as each institution that is involved either in conservation or in the utilization of natural resources pursues its own policies. Most of the current policies were developed in the 1980s and 1990s. However, the first foundations for physical planning were laid in 1973 with the passage of the Administration of Land Act, a law that introduced a lease holding system of land tenure in urban areas. After vigorous opposition by traditional chiefs on grounds that this law eroded their powers over land allocation, this Act was replaced by the Land Act, 1979 and by the Town and Country Planning Act, 1980 with the aim to provide for orderly development of land, and to preserve and improve the amenities on the same.

The Land Act, 1979 was the first major attempt to improve land management and land use in Lesotho by introducing leaseholds and the concept of selected development areas in order to facilitate the re-planning of selected areas. Despite various amendments to the Land Act, 1979, the traditional land tenure system remains fully operational in peri-urban and rural areas, with the result that there is a serious proliferation of villages and substantial encroachment onto fertile agricultural land, leading to increased landlessness, the cultivation of marginal lands, further land degradation, and higher levels of rural poverty. There are so far more than 25 relevant policy statements that have been developed amongst various sectors since 1988. These policies are supported by more than 30 pieces of legislation that have been passed since independence in 1966.

Experience in Lesotho has shown that enacting laws is no guarantee for the development of environmentally sound land use plans. Enforcement levels have generally been very poor due to: (a) overlapping and complex legislation; (b) gaps and serious omissions in the legislation; (c) a top-down approach in the development of legislation; (d) general ignorance of the relevant laws by law enforcement

agents,[35] and (e) overlapping institutional responsibilities. Many laws are out of print and therefore not available to the public. Dissemination of the laws is mainly by gazettes that are purchased at the Government Printer in Maseru. In addition, many laws are outdated and stipulate penalties that do not make sense in today=s economic realities. There is still a need in Lesotho for the development of an environmental ethic that can be integrated into local cultures and traditions.

An analysis of the current land use policies reveals that the government aims at creating an enabling environment for better land use by reviewing and applying relevant legislation, and through carefully targeted support for particular conservation based activities. The strategy also involves empowering local stakeholders through training and continued extension in order to enable them to take decisions to improve their land use and management of natural resources. In fact land use planning is seen as an important instrument to provide guidelines on the prudent utilisation of natural resources at the local, district and national levels. The strategy adopted to this end is to build a spatially based information system, which can be used directly for macro-level land use planning as well as for servicing the needs of multiple users in various sectors.

The current environmental law in Lesotho has been formulated using guidelines that were provided by international conventions which have been ratified by the country such as the 1992 United Nations Declaration on Environment and Development, the Statement of 15 Principles for the Sustainable Management of Forests, and the United Nations Programme of Action from Rio (Agenda 21). The policy calls for the entitlement of all citizens to a clean and healthy environment, the establishment and strengthening of institutions that are charged with addressing environmental problems, the development of a comprehensive codification of legal provisions relating to the protection and sustainable management of ecosystems and natural resources, and the setting up of a cross-sectoral regulatory framework.

The environment policy emphasises that environmental planning should be integrated with all development at the national, district and local levels, and gives the National Environmental Secretariat wide ranging powers that include: (a) ensuring that environmental impact assessments are undertaken for all major development projects, (b) monitoring compliance and auditing on-going activities, (c) controlling pollution, (d) declaring environmentally protected and heritage sites, (e) serving environmental restoration orders, (f) setting up environmental standards, and (g) promoting environmental education. At the present moment, however, NES has neither capacity nor authority to fully execute these functions.

The policy statement for the forestry and land reclamation sector defines the role of government as that of providing support to local people in beneficially managing their own natural resources. The policy has expanded the concept of food security to include fuel security, highlighting the following specific issues:

- conservation of the productive land, rehabilitation of degraded land, and conservation of water resources;
- appropriate planning and utilisation of the land resource; and
- increasing the contribution of trees to livelihood security and environmental protection.

Until very recently, Lesotho had no formally approved policy for its forestry sector. Notwithstanding this policy gap, the government has always assumed the lead role in the development and maintenance of forest resources since 1876. This continues to be the case, with very little planting being done outside government and international NGO initiatives. The adoption of a National Forestry Policy in 1988 marked a radical shift in direction by emphasizing an increased role for communities in forest management. As a result, in both the National Forestry Policy Action Programme of 1996 and the Forestry Act (No. 91) 1998, the government has firmly committed itself to local ownership of forest resources.

[35]Kumar, U. (1995) **Analysis of National Legislation of Lesotho, Mozambique, Tanzania and Zimbabwe with Respect to Natural Resource Management**, SADC-ELMS Coordination Unit, Maseru

It is the policy of the Lesotho Government to maximize, through actions consistent with other policies and development goals, the contribution that forests can make to the alleviation of poverty, livelihood security and environmental protection in Lesotho, and to enhance the participation and contribution of women in this endeavour with regard to the following objectives: increased production and employment creation, environmental protection and biodiversity conservation, forest research, and women empowerment. The strategy adopted involves extending support, primarily at the village level, through the supply of planting materials and provision of appropriate extension and training in tree planting and husbandry techniques.

Options for technology transfer

Adaptation options in the land use change and forestry sector have mainly centred on reforestation and agricultural development. In the area of reforestation, the aim has been to advance conservation objectives and to provide energy supplies and construction materials in the face of increasing scarcity of forest resources. On the other hand, efforts in agriculture have mainly centred on the promotion of production and productivity enhancing technologies. In this study, more emphasis was placed on reforestation as a climate change adaptation strategy.

The earliest reforestation initiatives in Lesotho were mainly concerned with soil conservation. It was not until 1973 that serious efforts at reforestation started with the introduction of the ODA supported Woodlot Project. Since then there has been a number of donor supported initiatives that included the Lesotho Poles and Fuel Wood Project that was initiated in 1987, and the KfW/GTZ supported Social Forestry Project that began in 1992. At the conclusion of the Social Forestry Project, there were 14,000 hectares of government owned plantations that were primarily earmarked for wood production. Since then, the stock has been expanded at a rate of 500,000 trees per annum although in the 2003/4 financial year, this number went up to 658,000 trees.

There is also an estimated 32,000 hectares of regenerating trees that have been planted over many years for erosion control. These are now regularly harvested by rural people for fuel wood and poles. Estimates also indicate that there are 165,100 hectares of indigenous forests. In fact the total number of trees in the 3 categories of forests that have been referred to above is 237.2 million. The government now plans to plant an average 1.5 million trees per year with active participation by schools, NGOs, and communities. There are now 117 privately owned tree nurseries that are run by people who have been trained in tree planting. These new entrepreneurs supply government at an average cost of M1.20 per tree seedling. However, the reforestation programme is severely constrained by funding and shortages of qualified personnel, and by limitations to private sector participation in commercial tree production that are imposed by the communal land tenure system.

Donga (gully) reclamation

Lesotho has been involved in the development of appropriate methods of donga reclamation for some time. The primary aim is to restore the dongas to productive use. The secondary aim is to prevent the spread of dongas into crop lands. Considerable experience has been gained through donor assisted initiatives. The GTZ supported Mafeteng Development Project found that donga reclamation could work if conducted on an individual land basis and in an environment where ownership is legally recognized. Attempts to reclaim dongas on a communal basis have invariably failed due to uncertainty over the sharing of future benefits, and due to disputes over who has put in how much work. Experience in these projects has also shown that there is a need for physical structures and biological measures to be put in place. Simply planting trees in a donga is not adequate for reclamation. Structures must be put in place to reduce water flow and accumulate soil in which cuttings or seedlings could be planted. Intensive supervision is required for the recommended measures to be implemented successfully, both in terms of advising on trees, shrubs, grass and planting location within the donga.

Most community members are willing to contribute labour but are unable to pay for inputs required, namely, planting material and construction materials such as cement, sandbags and mesh wire for gabions. These must therefore be provided from external sources. The techniques developed at Matelile in the Mafeteng District are now sufficiently tested that they could be applied in other parts of the country that have similar conditions.

Windbreaks

Windbreaks are strips of trees and/or shrubs that are planted to protect fields, homes, orchards or other areas from wind and windborne soil or sand. Large-scale, wide strips or blocks of trees planted for this purpose are often called shelter belts. Windbreaks are planted for many reasons: to reduce soil erosion, to improve the microclimate for growing crops, and to shelter people and livestock. They can also serve other functions, such as fencing and boundary demarcation. Where wind is a major cause of soil erosion and moisture loss in dry areas, windbreaks can increase and sustain crop productivity.

Ideal windbreak species should not have superficially wide-spreading roots, or produce suckers from the roots. They should be evergreen and retain lower branches as they grow. Where space permits, the planting of several rows would enable trees of different heights to be planted so as to form a more effective windbreak.

Although wind speeds are generally low over Lesotho, this is not the case during the months of August and September when strong winds cause frequent dust storms that result in the occurrence of widespread wind erosion. However, despite their usefulness, windbreaks are not frequently found in the country=s development landscape. Where they do occur, they have been planted mainly around home gardens to mark boundaries. The establishment of windbreaks around arable fields would require the agreement of a number of farmers due to the scattered nature of land holdings, and because of the communal land tenure system.

Land tenure problems also restrict the scope for the use of windbreaks around rangelands. The potential benefits of windbreaks in this case would appear to be larger than in arable land: provision of shade for livestock in summer, and shelter from rain or even snow in winter. The communal ownership of rangelands makes it difficult to enforce protection of the trees when young, and to regulate harvesting of wood from trees. Similarly, the practice of veldt burning often damages or destroys trees in rangelands. The general consensus amongst foresters has been that windbreaks appear to be most feasible when planted around privately owned yards, fruit tree orchards, and communal or cooperative vegetable gardens.

Inter-cropped orchards

Inter-cropped orchards involve growing vegetables amongst pruned fruit trees in gardens or orchards. This practice has not been studied in any detail by horticulturalists in Lesotho. As local markets are limited and local gluts can easily occur, it is important that any future studies should examine the feasibility of establishing orchards with a number of fruit tree species and varieties so as to spread out the period of time in which fruit can be marketed or consumed.

There would not appear to be any reason why vegetable inter-cropping should not be carried out with any fruit tree that requires pruning for optimum production e.g., peaches, apricots, apples, pears and plums. The performance of vegetables under lightly shaded conditions has never been studied in Lesotho, but a literature search could well come up with some relevant information from elsewhere. Experience in inter-cropping elsewhere has generally, but not always, shown a reduction in insect damage in inter-cropped systems. It would be relatively easy to study whether this is true or not for orchards in Lesotho.

Silvo-pastoral systems

This is taken to mean the growing of trees at wide spacing in rangelands so that forest products are produced in addition to livestock. Such systems have been developed in New Zealand and in the southern USA where wide-spaced pines are grown with pasture for both livestock production and saw logs. In Lesotho, although some scattered large trees are sometimes found in rangelands, this dual strategy of production has not yet been exploited. In any case, the communal land tenure system is likely to be an impediment.

Establishment of fodder banks

Fodder shrubs have been tested at various locations in Lesotho and a number of promising species have been identified. These have been planted in trials or as individual trees in dongas or in yards. As yet there are no examples of blocks of fodder shrubs being planted at close spacing (fodder banks), and there is as yet no information on fodder yields. Fodder banks are most likely to succeed when planted in fenced yards and close to the house as they would then be protected from accidental or illegal grazing. It remains to be seen if fodder banks can be successfully managed when planted in open fields.

Tree fallows

The objective of tree fallows is to improve the physical and chemical properties of croplands by planting soil-improving shrubs and trees during a fallow or rest period. The fallow period may therefore last a number of years until the woody crops are harvested. The area is then used for cultivation. This system has not been tested in Lesotho.

Tree fallows will probably only be attractive to farmers if they provide useful products in addition to the improvement of soil properties. They may thus become indistinguishable from the fodder banks described above, with the same species being used. Before attempts are made to introduce this farming practise in Lesotho, a number of questions must be answered. For instance: (a) Will it be possible to cultivate land despite the presence of tree stumps and root? (b) Are woody plants more effective at improving soil properties than, say, pulses? and (c) Which are the key soil limitations that need to be dealt with?

A variation on this farming system involves the planting of fast growing trees in fields that have poor drainage and low crop yields. The trees are simply planted as an alternative crop rather than as part of a rotation of crops. Some of the hybrid willows and poplars recently imported from New Zealand would appear to be well suited for this type of planting. Many farmers in the Matelile area (Mafeteng District) have become interested in this concept.

Alley cropping

Alley cropping is an agroforestry farming system where shrubs with good soil improvement properties are planted in rows, with crops planted between the rows. The shrubs have a number of functions: their clippings are used as a mulch to improve soil properties, the roots help bind the soil and reduce soil erosion, and woody material can sometimes be used for kindling fire. This farming system has been successful in the humid tropics, but in drier areas, competition for water can reduce crop yields. Alley cropping has not been tried in Lesotho, but there is interest in testing the concept.

It has been suggested that bund between arable fields be planted with fodder or soil improving shrubs, creating a form of alley cropping, with the aim to reduce soil erosion. Research would be needed to determine whether a vegetative barrier composed of shrubs is more effective in reducing soil loss than one of grasses. Suitable shrub species for alley cropping are the same as those for fodder banks but with the addition of the non-palatable species *Lupinus arboreus*, a short lived small shrub used in New Zealand for soil improvement. One of the foreseeable problems with alley cropping would involve the protection of palatable shrubs from animal damage or excessive browsing.

Where leguminous fodder trees or shrubs are used in alley cropping, it could be unrealistic to expect the farmer to use the leaves as mulch when they could be fed to his livestock. The use of foliage and twigs as mulch, however, is the main means by which alley cropping maintains soil fertility. Trials of these practices should therefore examine both scenarios: clippings used for mulch, and clippings used for fodder.

Live fences

Live fences are a familiar feature throughout much of the African landscape although in Lesotho they are mainly found in urban areas. The purpose of live fences may vary, perhaps most often people plant them to keep out domestic or wild animals. In other cases, they may demarcate areas where general access is discouraged, such as around a compound, house, cropland, garden or orchard. The key element in most African land use systems is to use live fences to control the movement of wild and domestic animals, yet in Lesotho they are mainly used to restrict access.

The majority of plants in live fences are low, rarely over 2m tall, and the fence as a whole is dense and impenetrable. Trees or shrubs are planted close together in one or more rows. As they grow, the plants are trimmed and, for some species, the branches are woven around the stems to form a thick, dense barrier. In other situations, full-size pollarded trees are used as live fence posts with dead branches, barbed wire, or timber woven in between. Low and dense live fences may also contain individual trees that are allowed to grow to their full height at intervals.

Trees and shrubs along roads

Areas along roads are often available for planting multipurpose trees and shrubs. Trees in these areas provide shade, reduce dust on adjacent land, and, if properly managed, provide wood, fruit, insect and animal fodder and other uses. In treeless areas, therefore, roadside planting may be a significant source of tree products for local communities. In areas where access to trees is limited, poor and landless people may derive an important income by harvesting tree products from roadsides.

Roadway drainage can cause major erosion damage and siltation in rural watersheds, but much of this can be prevented by incorporating simple channel-control structures and vegetation into road design and construction. Trees, shrubs and grass cover can stabilize freshly disturbed ground, and vegetation along roadways can protect cut and filled slopes. The Department of Rural Roads is currently examining ways of redressing erosion impacts of rural roadways.

Trees and shrubs around houses and in public places

The urban and rural landscape could have been far less pleasant and unproductive if it was not for a wide variety of shrubs, trees, vines, grasses and other plants around houses and home compounds, around schools, in market places and in other public places. While this may not be agroforestry in the strict sense, trees and their products in these locations are just as important as if they were growing on croplands and rangelands.

The growing of trees around houses, home compounds and in public places is a standing tradition throughout Africa. Community meetings are often held under an especially large, shady tree that may have special significance for the local people. Trees planted in home compounds may eventually form part of home gardens, small orchards, tree nurseries, or livestock enclosures as land uses change. Their contribution to the well being of rural households is often underestimated by outsiders. However, both formal surveys and informal reports indicate that rural people are keenly interested in planting trees around their houses and compounds. In Lesotho, trees are better managed and have a higher chance of survival in home compounds where they can be protected, watered and harvested with ease than anywhere else in the landscape.

Woodlots

In woodlots trees are planted in blocks with the main aim to cater for energy needs and construction materials. Woodlots have been planted under various government schemes with donor assistance as has been reiterated at the beginning of this chapter. Species planted are mainly pines and eucalyptuses. The largest woodlots tend to be hidden from view, being located on plateau tops. In general, the rate of harvesting has not been high enough, the main reason being either that there is an inefficient marketing system or that people cannot afford the wood.

Barriers to the implementation of technology options

The main barriers that inhibit the implementation of adaptation technologies in the land use change and reforestation sector in Lesotho have been cited as:

- The communal land tenure system that provides little incentive to the individual to improve or protect arable land and communally grazed resources, and the associated risk of investing in agricultural improvement;

- Poverty with its limitation of the ability of many households to engage in conservation activities that may require purchased inputs;
- Low returns relative to other opportunities;
- Advanced environmental degradation that compounds and exacerbates the risk factor and reduces potential returns; and
- Low priority accorded by local people to conservation activities relative to other imperatives.

As was discussed under the policy framework, a number of initiatives to address these barriers to technology options are currently under consideration. These include the creation of a policy and legal environment that will enable and facilitate local initiatives in forestry development; the development and dissemination of technologies and approaches to forestry development that are appropriate to local development objectives, local conditions and circumstances; increased local management of indigenous vegetation resources; increasing the quantity and suitability of planting material available to people that are interested in planting trees; and the promotion of forestry development through a widening of information channels.

6. CONCLUSION AND RECOMMENDATIONS

The overview

The prevailing unfavourable agro-climatic conditions in Lesotho, and associated unacceptably high levels of poverty and unemployment, are some of the imperatives that compel Lesotho to formulate and adopt strategies for technology development that can ensure the country=s survival in the current global economic order. This need is even more urgent when viewed against prospects of dry and warmer conditions that are predicted by various climate change scenarios. Unfortunately, while there is a general acceptance that science and technology form the basis of national development, its application nationwide is still at a gestation stage. In the absence of a consolidated national policy on technology development, and in the face of historical and cultural constraints, the solution of the country=s problems through technological development has been going at a snail=s pace.

Despite the imperatives that have been cited above, it is only recently that efforts to develop a national policy on technology development were initiated. Up until now, technology development initiatives remain fragmented and donor driven, each being guided mainly by the policies of the sector in which they are operating. The intricate relationship between technology development and adaptation to climate change is little understood. Local support for research and technology development, whether public or private, remains weak. Similarly, interest in the results of technology research remains marginal, with very low private sector investment in production and dissemination. These weaknesses, there is no doubt, undermine the central role that technology development is expected to play in the formulation and implementation of adaptation options to climate change.

There are historical reasons to explain low support for technology development initiatives in Lesotho. These include the plunder of traditional knowledge systems by colonial administrators and the related emergence of cultural inferiority in the country. Also associated with this development was the gradual weakening of economic nationalism that made Basotho an import-oriented society. The ready availability of expensive and, many times, irrelevant, imported technologies has undermined the development of cheaper and more relevant technologies in the country. The problem is exacerbated by the continued orientation of the education system towards academic as opposed to practical solutions, and by lack of meaningful incentives for those who embark on science and technology research.

There is also evidence of lack of understanding of the role and benefits that could accrue from technology development, and of the support inputs that are necessary for such breakthroughs. This is evidenced by meagre financial resources that are allocated to technology research, as well as by the failure to allocate adequate professional skills to implement successful research programmes. Many donor-supported and donor-driven initiatives of the past were therefore largely unsustainable. On the beneficiary side, poverty, illiteracy and lack of entrepreneurship remain the major obstacles to the adoption of new innovations.

As a starting point, therefore, it is essential to have a comprehensive documentation of the technology breakthroughs of the past and to advocate for resource allocations that are proportional to policy pronouncements and priorities. It is also necessary to undertake comprehensive assessments of adaptation technological needs in a wider range of sectors of the economy in order to facilitate policy formulation and programme prioritization.

Science and technology policy

International concerns, as reflected in various conventions to which Lesotho is a signatory, are very emphatic on the need to forge scientific and technological breakthroughs, particularly in countries that are very vulnerable to adverse effects of climate change. The transfer of technology for adaptation to climate change is regarded at the international level as a crucial component of reducing vulnerability to climate change. In an attempt, therefore, to address constraints to technology development, the draft policy on science and technology encompasses the following core elements:

- the promotion of a science and technology culture, infrastructure and links;
- the facilitation of access to up-to-date, reliable, and cost-effective science and technology;

- the full exploitation of the country=s natural and human resources and science and technology investments;

- the equitable distribution of science and technology benefits; and

- the promotion of standards and mutual respect for intellectual property, including indigenous knowledge systems.

It is not clear how this policy will be implemented. So far the DST, the custodian of this policy, remains a policy formulation and advocacy institution with very weak linkages with various operational science and technology institutions and stakeholders. In addition, the institution lacks a data bank that could provide a framework for either policy or programme formulation. For the above policy objectives to be realised, therefore, some elements of institutional modifications and rationalizations, including the elimination of overlapping responsibilities, will need to be undertaken and programme funding mechanisms clearly defined. There must also be a clear support and resource commitment to these objectives by relevant stakeholders, as well as the establishment of performance monitoring mechanisms to ensure stakeholder accountability.

National Experiences

In the past 3 decades, Lesotho gathered useful experiences with technology development, particularly in the areas of agricultural research, research on labour-intensive construction, and research on technologies that were deemed appropriate for rural communities. Most of the technology development programmes were donor supported and independently executed by government agencies, each with a specific mandate and organizational approach. Other technologies that have been developed for rural communities include gravity-fed systems and hand pumps for rural water supplies, the VIP latrine for rural sanitation, low-cost housing schemes for low-income and poor households, labour-intensive farming systems, labour-intensive soil conservation structures, and various methods of recycling waste. Unfortunately, most of these initiatives were donor driven and their sustenance has proven to be very difficult.

Amongst officials today, there is a consensus that the sustenance of initiatives of the past has been directly dependent on the continued flow of donor funds. Although there is currently renewed interest in science and technology, particularly at the policy levels, there is as yet no indication that there will be dramatic and significant changes in the allocation of both public and private resources to technology development institutions and enterprises. On the other hand, a number of technology development initiatives have also been undertaken by the private sector, by civic organizations, and by independent projects. Their fate, however, has resembled that of government initiatives.

In agricultural research, technology development initiatives have shifted emphasis from support for dry land farming of traditional crops to research on soil improvement, range recovery, seed multiplication, the development of appropriate mechanization systems, the development of simple irrigation techniques, and the collection and conservation of germ-plasma. A number of twinning arrangements have been opened with regional and international institutions for this purpose. However, the dissemination of new agricultural technologies is still hampered by low institutional linkages and capacities, illiteracy, and farmer poverty.

The design, testing and dissemination of new technologies that matched the needs and resources of rural people has been going on since the 1970s, with a concentration on productive activities such as food processing and preservation, income generating activities such as spinning and weaving, production of building materials, and energy production and conservation. Today, work continues at the ATS on the development of food technology, renewable and biogas technology, and small-scale agricultural implements and technology. Despite the fact that a range of mature technologies is now being marketed, collaboration between the ATS and other major stakeholders remains weak and piecemeal. Not only is the ATS constrained by limited budgetary support and low professional capacity, but there is limited investment in technology development and production by local industries.

The development and application of labour-intensive technologies has found its home in rural road construction, environmental protection and rehabilitation, and in the construction of soil conservation structures. On the other hand, a number of private sector information technology initiatives have emerged

in Lesotho, leading the government to establish a new Ministry, a focal point for policy formulation. On the other hand, although attempts have been made to register and protect local technologies and innovations, nationwide dissemination and transfer of these local artefacts remains weak, the main reason being low interest by the private sector and inadequate financial support by government.

There is an urgent need to document Lesotho=s experiences with technology development in various sectors of the economy. Most of these experiences have gone with the phasing out of projects and with the transfer or retirement of professionals. Lack of continuity in records is also responsible for lack of continuity in technological development activities. With the institutional rationalization that has been advocated above, all technology development efforts and prototypes would have to be registered with the DST, an institution that should keep a national technology data bank.

Technology, education and training

Lesotho, like many developing countries, lost a substantial part of her cultural traditions and values through the process of colonization. The outlawing of many traditional practices and the forced adoption of foreign cultural values and traditions led to a severe erosion of indigenous traditional knowledge systems in the country. This disruption has compelled Lesotho to depend heavily on imported technologies, many of which are not well adapted to local conditions. As a result, the country has not been able to develop an integrated system of technology development, leading it to be turned into a consumer of imported, un-adapted and largely inappropriate technologies rather than a generator of Alocally-brewed@ and appropriate technologies.

While a lot of emphasis has been placed on the teaching of mathematics, science and technical studies in all of Lesotho=s development plans, up until now institutional training has largely remained academic and generic as against adaptive and inventive. The content of the education system has been described in official documents as marginally relevant to the development needs of the country, while the teaching of science and mathematics, both of which are critical to technology development, has been described as very weak. The implementation of new curricula is generally hampered by inadequate support infrastructure, the shortage of science and technical teachers, inadequate equipment and teaching aids, weak management at the school level, and the need to retrain teachers in new approaches.

At the technical and vocational level, educational objectives emphasize the facilitation of the development of productive human resources with skills and aptitudes that are necessary for the promotion of a dynamic and sustainable economy, the development of entrepreneurial skills and integration of these with technical and vocational education and other training programmes. Unfortunately, it has been difficult for Lesotho to develop and retain human resources within the country since it is totally surrounded by the RSA which offers higher salaries and better working conditions. Most of the young and more innovative Basotho who have been trained in science and technology either inside or outside the country are often attracted to countries with better pay and more appropriate infrastructure for their services, the RSA being the main beneficiary. The absence of job opportunities inside the country, and the orientation of the education system towards training for jobs as opposed to training for employment, do not seem to help the situation.

In all official documents on education and training, the government has committed itself to the promotion of activities relating to science and technology in school curricula, and high priority is given to the teaching of mathematics and science at all levels of the education system. The aim is to make school syllabi more relevant by incorporating more practical and imaginative day-to-day applications using locally available materials. The government further aims at the production of local low-cost teaching aids for both primary and secondary schools. On the other hand, with a widespread recognition of the value of indigenous knowledge systems and growing interest in the same by the international community, and with attempts to seek mutual support and common ground between modern and traditional technologies and value systems, it is necessary for Lesotho to embark on a revitalisation of her cultural and indigenous knowledge systems and harness these for development in various areas including biodiversity, medicinal plants, land use and the environment, community development, etc.

The laws guiding technical and vocational education are currently under revision with the main aim to provide apprenticeship training and improve the practical orientation of courses. Unfortunately, the attainment of these objectives is hampered by the fact that there is currently very weak coordination

between industries on the one hand, and technical and vocational institutions on the other. This has resulted in the failure to closely match training with the practical needs of the country, with many graduates finding it difficult to get jobs. On the other hand, there is sufficient basic infrastructure at the Lerotholi Polytechnic for the country to establish a university of technology that will assess local technological needs and bring to bear experiences of various technology development institutions.

Part of the weaknesses of technology development programmes emanate from the fact that there are no clear relationships between technology development institutions , on the one hand, and technical and vocational training institutions, on the other. Not only is there a need to define and strengthen this relationship but to develop an apprenticeship programme in which there will be participation by these institutions and local industry.

Technology Needs in the Energy Sector

Low industrialization and poverty have given a traditional characteristic to Lesotho=s energy demand pattern. There is a rising demand for biomas fuel sources that has been blamed for deforestation, soil erosion and land degradation, loss of soil fertility, declining agricultural production and productivity, and dwindling biodiversity. Despite this unsustainable demand pattern, lack of affordable energy alternatives and population growth indicate that biomas energy sources will continue to be main sources of energy in Lesotho for some time, particularly in the rural sector.

The link between biomas fuel use, depletion of organic soil nutrients, land degradation, and poverty has compelled the government over the years to embark on tree planting programmes with a multi -purpose objective to provide fuelwood, to reduce pressure on the limited biomas resources, and to release animal dung for utilization as manure. As a result, policies in the energy sector have put a lot of emphasis on expanding renewable energy sources and implementing biomass development programmes. The draft energy policy that has recently been concluded aims at ensuring that energy is universally accessible and affordable in a sustainable manner, with minimal negative impacts on the environment. Amongst major objectives of this policy are the following:

- Contributing towards poverty alleviation - developing and disseminating affordable technologies and services; and

- Ensuring access to basic energy technologies and services - choosing affordable, reliable and quality technologies and services that will be sourced within the country and in the sub-region.

The energy policy strategies advocate the development of indigenous energy sources, substitution of imported commercial energy sources with alternative indigenous sources, expansion of indigenous hydro-power generation and electricity distribution infrastructure, and the promotion of energy conservation in various sectors of the economy. However, the DOE, the focal point for this policy formulation, is merely involved in sector coordination activities and therefore might find it difficult to ensure successful implementation of the above policy objectives, let alone to enforce issues in an environment that involves a multiplicity of both public and private sector institutions that have divergent interests.

Technology transfer initiatives in the energy sector have largely been confined to the expansion of renewable energy and energy conservation. Other than biomas and hydro-power, renewable energy currently plays a minute role in the economy. On the other hand, since less than 5% of the households have access to grid electricity, renewable energy could play a very important role in meeting household energy requirements. In addition to hydro-power development, where successful import substitution has been demonstrated by the commissioning of the >Muela hydro-power plant, there has been a lot of efforts to develop and disseminate photovoltaic systems and appliances such as solar water heaters and cookers and solar dryers. In addition, experiments on biogas digesters and wind energy generation are still in progress, with very little government support.

In the development of renewable technologies, emphasis is placed on the development of affordable devices that are not only locally serviceable but are of quality standards. Attempts are therefore underway to develop regulations that will guide the development and marketing of these technologies, to organise financing mechanisms that are suitable for economic conditions in Lesotho, and to investigate possibilities

of removing levies on imports. Support initiatives for the utilization of renewable energy technologies for income generating activities are under investigation, as are possibilities of the establishment of capacity for the maintenance of renewable energy installations.

Other strategies to promote renewable energy technologies include undertaking awareness campaigns using different types of media such as radio, establishment of demonstration units, and expansion of training programmes and school curricula to accommodate these technologies. However, despite these efforts, there are constraints that lower the rate of adoption. These include low affordability due to high initial investment costs, poor workmanship during installation, lack of qualified maintenance personnel, inadequate information and public awareness, and theft and vandalisation of installations.

Activities in energy conservation have mainly focussed on the improvement of building designs and the development of heat conserving, energy-efficient technologies. The demand for investments in other sectors of the economy could be met from solar gains that accrue from proper building orientation, as well as by adopting appropriate architectural designs, including the use of thermal insulation. A number of mature technologies are now being disseminated by ATS. On the other hand, the Department of Energy has developed guidelines for energy-efficient buildings. However, the existence of an informal property market in rural and peri-urban areas where there are no regulations governing building plans and construction, lack of enforcement of building regulations in urban areas, extra costs that are associated with some energy conservation measures, and the absence of established property developers, pose serious constraints to the adoption and incorporation of these guidelines.

The main strategies that are advocated for the dissemination of new technologies by energy sector policies are public campaigns and incentives. However, the latter merely exist on paper without any concrete applications because the commitments of government financial planners and managers has never been secured. Since most of these technologies are tied up to environmental recovery, financial incentives should be designed and presented to these officials for approval and implementation. These incentives should apply both to participating companies as well as to individuals that purchase new technologies. Some of the confidence in new technologies is eroded by poor workmanship, and closely tied up to the challenge of re-orienting training to the needs of the economy.

Land use change and forestry

The importance of the land resource in Lesotho derives from the fact that 85% of the population is classified as rural, where agriculture is a major source of livelihood for 80% of the population. However, factors that have exposed the country to severe soil erosion (topography, the variable rainfall pattern, animal and human pressure, the cultivation of marginal lands, poor land management practices) threaten the stability of this livelihood source, compelling Lesotho to perpetually depend on food imports and food donations. In addition, agriculture has become increasingly sensitive to climatic conditions in recent years, resulting in the sector=s declining share of the economy. However, despite this development, there is a dire need for technological breakthroughs in the agricultural sector to expand employment and incomes and avert increases in poverty that are likely to be brought by adverse effects of climate change and population growth.

In recent years, population pressure and the need to move away from remoteness have forced widespread encroachment of settlements onto areas that were traditionally reserved for agriculture. On the other hand, the shortage of agricultural land has also forced the cultivation of mountain slopes (marginal lands), with devastating results on soil stability, the quality of the range, and livestock productivity. There is a growing concern that uncontrolled growth of settlements, rural road construction activities, the cultivation of marginal lands, labour-intensive mining, etc have deleterious impacts on the environment and therefore efforts must be made to control these activities, and land use planning is seen as an important instrument to provide guidelines and a framework for the overall prudent utilisation of natural resources.

Adaptation options in the land use change and forestry sector have mainly centred on agricultural development and reforestation. In agriculture, actions have included attempts to match cultivars with agro-ecological conditions, the promotion of production and productivity enhancing technologies, promoting the use of kraal manure, soil liming, crop densification, multiple cropping, irrigation, culling and breed improvement, grazing control, etc. Unfortunately, most of these innovations have not been sustainable

due to, among many reasons, financial limitations on the part of the farmers, inadequate extension services, and erratic climatic conditions. Land utilization in most parts of the country remains under the communal land tenure system, making it difficult to control (a) the encroachment of settlements onto agricultural lands, (b) the cultivation of marginal lands, and (c) the unsustainable utilisation of forest resources. This situation that has resulted in reduced vegetation cover, extreme land degradation, and loss of biodiversity.

Despite harsh climatic conditions and problems of animal and human pressure on forest resources, the government recognises the important role that trees play in soil stabilisation and sustainable land management, in providing shelter from destructive winds, in improving the water holding capacity of catchments, in providing fuel needs of rural communities, in providing building materials, and in improving aesthetics. However, there are constraints facing current intervention programmes. These include protracted droughts, inadequate funding and associated poor participation by the private sector, destruction by veldt fires and animals, vandalism by communities, and inaccessible sites. Not withstanding these and other problems, reforestation provides Lesotho with the only realistic means of attempting to meet future rural energy demands.

In the area of reforestation, the objectives have been to advance conservation and to provide energy supplies and construction materials in the face of increasing scarcity of forest resources. Current policies emphasize the maximization of the contribution of forests to poverty alleviation, livelihood security, and environmental protection, and to enhance the participation and contribution of women in this endeavour with regard to increased production and employment creation, environmental protection and biodiversity conservation, forest research, and women empowerment. The strategy that has been adopted involves extending support, primarily at the village level, through the supply of planting material and provision of appropriate extension and training in tree planting and husbandry techniques.

The reforestation programme is severely constrained by funding and shortages of qualified personnel, and by limitations to private sector participation in commercial tree production that are imposed by the communal land tenure system. The communal ownership of rangelands makes it difficult to enforce the protection of trees when they are young, and to regulate harvesting of wood from trees. The establishment of windbreaks around arable fields would require the agreement of a number of farmers due to the scattered nature of land holdings, and because of the communal land tenure system. Similarly, attempts to reclaim dongas on a communal basis have invariably failed due to uncertainty over the sharing of future benefits, and due to disputes over who has put in how much work. As a result, a lot of innovations in soil conservation, reforestation, improvement of soil fertility, etc. carry potential that has not been fully exploited in Lesotho.

A number of initiatives to address barriers to technology options in forestry are currently under consideration. These include the creation of a policy and legal environment that will enable and facilitate local initiatives in forestry development; the development and dissemination of technologies and approaches to forestry development that are appropriate to local development objectives, local conditions and circumstances; increased local management of indigenous vegetation resources; increasing the quantity and suitability of planting material available to people that are interested in planting trees; and the promotion of forestry development through a widening of information channels. However, as long as there is no political will to resolutely deal with the problem of communal land tenure, it remains to be seen if these new strategies will bring material changes.

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